VOL. I FIRST QUARTER, 1930 No. 1

The Philippine Journal of Agriculture

[Formerly THE PHILIPPINE AGRICULTURAL REVIEW]

PUBLISHED QUARTERLY BY THE

BUREAU OF PLANT INDUSTRY
AND THE
BUREAU OF ANIMAL INDUSTRY

DEPARTMENT OF AGRICULTURE
AND NATURAL RESOURCES

MANILA
BUREAU OF PRINTING
1930

Entered at the Post Office at Manila as second-class matter

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SUBSCRIPTION RATES: ₱2 (Philippine currency) or $1 (U. S. currency) per annum in the Philippine Islands and the United States territories. $2 (U. S. currency) per annum in foreign countries.

Subscriptions should be paid in advance in the form of a post-office money order or draft drawn on a Manila bank in favor of the Bureau of Plant Industry, Manila, Philippine Islands.

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OUR NEW NAME

With this issue we change our name from "The Philippine Agricultural Review" to THE PHILIPPINE JOURNAL OF AGRICULTURE. Twenty-two years ago the then Bureau of Agriculture started the Review to take the place of the Press Bulletins it issued and to provide a medium by which the Filipino farmers might be apprised of good agricultural methods in vogue in other countries, through the publication in its issues of abstracts and reviews of articles, treatises and books on agriculture that it was thought might be of interest and value to them. But as the years passed and as experimentations and investigations began to bear fruit and concrete results were obtained therefrom, original articles written by the technical personnel of the Bureau of Agriculture and dealing with this work began to appear in "The Philippine Agricultural Review." Then the contents of the Review practically became original articles and only a few pages thereof were devoted to abstracts and reviews, so that the name of the paper was virtually a misnomer; hence the necessity of changing it.

The PHILIPPINE JOURNAL OF AGRICULTURE will be the organ of the two newly created Bureaus, namely, the Bureau of Plant Industry and the Bureau of Animal Industry and will publish the results of research, experiments and investigations conducted by these Bureaus and articles written by scientists in other institutions. The Journal will also continue as a medium of exchange with scientific institutions abroad.

EXPERIMENTS ON CIGARETTE TOBACCO PRODUCTION IN THE CAGAYAN VALLEY, 1925–1929

(A Progress Report)

By DOMINGO B. PAGUIRIGAN
Agronomist, in Charge Tobacco Investigations

Looking back five years we note that the importation of manufactured cigarettes into the Philippines had reached the million-peso mark and since then it has steadily increased until in 1927 (the latest figures available are only for this year) it reached the appalling figure of over two and a half million pesos or an increase of 250 per centum in the short period of only four years. And while our customs figures for 1927 show that we imported ₱1,801,209 worth of leaf tobacco, to be exact, and we have been used to thinking that this was virtually all cigar wrapper leaf, we know at least now for sure that a considerable portion of our recent importations of leaf tobacco are American (Virginia, U. S. A.) or cigarette tobacco because there are now several factories in Manila that are manufacturing aromatic cigarettes from this leaf. So while we have been concentrating our efforts on the possible elimination of foreign cigar wrapper leaf in the manufacture of our cigars, we are actually confronted by a bigger problem, namely, the production of cigarette leaf tobacco that has presented itself not gradually, as that of the cigar wrapper, but abruptly.

What is the cause of this tremendous importation of foreign (virtually all American) cigarettes into the Philippines? There are several causes, to wit:

First. Tobacco smoking in all its aspects is also subject to fashion changes, especially with regard to the color of the leaf. In the same manner that the fashion now prevailing in cigars requires that the wrappers should be mousy-brown in color, in cigarette fillers the bright or yellow color has become the standard par excellence. Of course, there are other important factors to be considered governing the standard quality of cigarettes as a whole, but the color of the fillers is indeed of the utmost importance.

Second. American cigarettes are carefully and colorfully manufactured and packed.

Third. American manufacturers and distributors spare virtually no expense in tremendous advertising campaigns, whereas ours are only beginning to realize the value of this course.

Fourth. In the same manner also that fashion affects clothes, so it also affects the form of manufactured tobacco smoked. As man becomes busier, he can no longer afford or indulge in the luxury of half or partially smoked cigars. He must use smaller cigars or cigarettes which he can smoke during his short intermittent spare moments. That cigarettes are preferred to small cigars is due to the fact that the former can be better and more conveniently and economically manufactured and packed into all kinds of attractive receptacles. For instance, the color of the cigarette paper can be of any kind and you can initial it or print any beautiful decoration upon it, but the cigar can only have the different shades of the brown wrapper leaf. The latest news is that in England the ladies demand cigarettes to match their dresses.

Already, as hinted in the beginning of this paper, there are some Philippine manufacturers who are turning out cigarettes similar in quality and packing to the imported product. But to do this they have been forced to import the raw material as already pointed out also. Precisely because of this vital fact, the Bureau of Agriculture (now Bureau of Plant Industry) wasted no time in launching a series of experiments tending to bring about the local production of at least the raw material now being imported and subsequently to stop the importation even of manufactured cigarettes. And because of the tremendous importance of this problem, this paper has been prepared as an advance report on the progress of the experiments. We realize that there is still a great deal to be done but our results thus far are encouraging enough to point to a favorable solution of the problem.

GENERAL CONSIDERATIONS AND REVIEW OF LITERATURE

Although it is well known that tobacco grows well in the Philippines, it is also known that the slightest variation in soil and climatic conditions as well as in cultural methods promptly affects the tobacco plant. Even taking a single municipality in Isabela Province, variations in the quality of the tobacco product among different barrios notwithstanding identical time and methods of planting are to be noted. As before said the main features of the cigarette leaf tobacco it is desirable to produce locally are its bright brown or yellow color, sweetish taste and peculiarly strong aroma. There are varieties which possess the last feature but under our prevailing methods of culture, we have never succeeded in producing tobacco possessing the other

two features. The problem, therefore, consists of producing a product embodying such characteristics, if not better ones.

In the same manner that the production of Sumatra-like cigar wrapper has been made possible through a study of the methods in vogue in the countries actually producing them satisfactorily, it is hoped that American-like or Turkish-like cigarette leaf tobacco will be evolved.

Now to consider the different phases incident to the culture of cigarette tobacco with reference to actual conditions and prevailing practices in the Philippines:

The soil.—According to Scherfius and Woosley(21) the best tobacco in Kentucky is grown on a heavy brown or pale yellow loam resting on a stiff clay. According also to Mathewson(12), Mathewson and Mos(14), Currin(5) and Westbrook(23), the brightest tobacco is produced on light sandy soils with clay subsoils such as those found in North Carolina, South Carolina, Virginia, and Georgia. Philippine tobacco lands are generally fertile at present so that the question of fertility of tobacco lands elsewhere need not be considered here. Suffice it to say with regard to soil types producing supposedly the best cigarette tobacco in other countries, that these are also available in the Philippines.

The climate.—Anderson(1) claims that the season of 1911 was good for tobacco in Virginia. And the rainfall during the growing period of two months of tobacco during this season was 147.32 millimeters. The four-year average of rainfall during a similar period at Ilagan, Isabela, was 129.2 millimeters which differs from the former by 18.12 millimeters only. With respect to temperature, the similarity is more remarkable, for McNess, Mathewson, and Anderson(17) point out that during the season of 1905, which was also considered good, the mean temperature for June was 23.5° C. and for July, 24.5° C. Compare these with the three-year average at Ilagan for January and February which were 23.6° C. and 24.3° C., respectively. It is understood of course that the optimum growing period of cigarette tobacco in Virginia is during the months of June and July, whereas in Isabela Province, it is during the months of January and February.

Seed-beds.—The preparation of tobacco seed-beds is more complicated in the United States than in the Philippines because there the seeds are sown during cool to cold weather. And means are provided to retain sufficient heat in the beds either by covering them with glass or cloth, etc. Fortunately because

of our tropical climate, we do not need to use so much precaution with our seed-beds. As a matter of fact the seed-beds for cigarette tobacco in the Philippines only need to be prepared and managed in the same manner as for cigar filler tobacco and almost every tobacco grower in the Philippines is quite familiar with this process.

Varieties to plant.—The choice of variety to plant for the production of cigarette tobacco in the Philippines is the first most important item of our problem. In the first place, we have no native variety that inherently produces yellow and sweetish leaf tobacco. It is precisely because of this fact that the Bureau of Agriculture (now Bureau of Plant Industry) began four years ago (almost at the same time, the importation of cigarettes began to be really appreciable and alarming) the introduction for acclimatization tests of such exotic varieties as are already famous for the production of standard cigarette leaf tobacco. And since this acclimatization work has been in progress, other means of producing suitable varieties from native stock have not by any means been overlooked. These means are persistent testing and selection from native stock and hybridization work.

There are, so far as is known, only six distinct cigarette tobacco varieties grown outside the Philippines. Garner(9) says that there are really only four American varieties used in the production of cigarette leaf tobacco; namely, White Burley, Maryland, Orinoco, and Pryor, and that the numerous so-called varieties are really subvarieties of the four named. The other two are of Turkish origin. At the Ilagan Tobacco Experiment Station, there have already been introduced the two best American with several subvarieties and the two Turkish varieties.

It is curious to note that as early as the year 1895, Turkish, Ordinary Kentucky, Kentucky White Burley, and the three Hungarian varieties—Debroc, Czetnek, and Verpelet—were introduced at the Ilagan Tobacco Experiment Station then known as "Estación Agronómica de la Isabela"(20) under the supervision of Spanish agronomists. We have failed to trace these varieties, however, although our native Espada and Repollo varieties apparently possess resemblances to some of the Orinoco types of American origin. Leaño(11) also reports having tried in 1917 at Los Baños, seven American subvarieties representing two varieties. He obtained successful results but nothing has been heard from this so important work since.

Land preparation and management.—This phase of the culture of cigarette tobacco is also identical with that of cigar filler tobacco and therefore may be set aside for the present. And the

question of crop rotation and application of fertilizers is not as yet of vital importance to tobacco growers in the Philippines, much less with regard to cigarette tobacco the production of which nobody has as yet tried commercially. However, because Mathewson(13) and (14) and McNess and Mathewson(16) say that although Virginia soils contain sufficient lime, occasional liming is nevertheless important. Liming tests are worth conducting under Philippine conditions with special reference to cigarette tobacco production.

Transplanting.—Owing to variations in the size of the different cigarette tobacco varieties, the distances of setting out the young plants in the field naturally varies according to the variety to be used. McAmis(15) recommends 40 to 50 centimeters between plants in rows in Tennessee. In Virginia(2) the usual practice is to make the rows slightly over 1 meter apart and set the plants slightly over 90 centimeters apart in the row. Barnett(3) recommends in Kentucky the same distance between rows as in Virginia but 35 to 50 centimeters between plants in rows. For the smaller Turkish varieties, Clarke(4) recommends about one meter distance between rows and about 60 centimeters between plants in the rows and gives the general rule that the richer the soil the closer should the plants be in the row.

With the exception of the fact that transplanting machines are in general use in the United States, the principles governing the planting of tobacco in that country are generally identical with those prevailing in the Philippines for cigar filler tobacco. Comparatively low labor wages still prevailing here make the use of planting machines for the present unnecessary.

Cultivation.—Present Philippine methods of cultivating tobacco fields are satisfactory when applied to cigarette tobacco production.

Control of insect pests and diseases.—Because of peculiar local conditions and because virtually the same insect pests and diseases attack all types of tobacco raised in the Philippines, it is suggested that the reader refer to circulars Nos. 85 and 171 of the Bureau of Agriculture for information as to these.

Topping and suckering.—This feature of cigarette tobacco production is very important because, more so than in the case of cigar wrapper or cigar filler, the body of cigarette leaf tobacco must be of a specific nature. There was a time when heavier or thicker tobaccos were very popular, with the result that very low topping of the tobacco plants in the field became a general practice. Now, however, with the growing tendency

for milder smokes—cigars or cigarettes—the practice has about stopped. Curiously enough the accepted practice now is the same as we have found practicable for cigar filler tobacco, that is, the plants should be topped only when the flower head becomes visible. This method insures the production of the much desired medium-bodied leaves. Suckering invariably follows topping because after this the suckers begin to grow rapidly. Regarding this matter, Shaw and Ram (22) even go to the extent of dispensing with topping as well as suckering, if further necessary, in case the crop has been grown on land that is heavy and rich in nitrogenous matter.

Harvesting.—Although for a long time and possibly because of high labor rates in the United States, the practice of harvesting cigarette tobacco by cutting the whole stalk has been generally practiced, there is a move in North Carolina now to discourage this procedure in favor of the priming method which is the practice here as a rule. Moss (19) gives the following interesting conclusions in comparing the method of harvesting cigarette tobacco by priming and that by cutting the stalks:

Four years' experiments have shown that the yield of tobacco can be materially increased by priming the leaves as they mature instead of by cutting the stalk. These tests indicate that an increase in yield of 25 to 35 per cent may be expected by priming.

The increase in value per acre from priming has averaged $49.03 for the four years of the tests. This increase in value has been due mainly to increase in yield and to a lesser extent to better average colors.

The tobacco land can be maintained in a higher state of fertility when tobacco is to be primed, without serious danger of damaging the quality of the cured leaf.

For priming tobacco the plant ordinarily should be topped two to four leaves higher than for cutting. On rich land it may be topped four to six leaves higher.

Less barn room, storage room and fuel are required per pound of cured leaf when the crop is primed than when it is cut.

While, however, priming is the prevailing method of harvesting cigarette tobacco in North Carolina, the method of stringing or poling is different from that practiced in the Philippines, for according to Garner (9):

The string is attached to an end of the stick and near this end is passed once around the stems of three to five leaves, thus forming a small bunch which will hang to one side of the stick. The string is then drawn diagonally to the opposite side of the stick and similarly looped around a second bunch of leaves and the process repeated until the stick is full, when the free end of the string is attached to the other end of the stick.

But in the case of Turkish tobacco the leaves are strung singly with a needle in practically the same manner as in cigar wrappers, except that the leaves are not necessarily arranged back to back or face to face. They are also spaced about $\frac{1}{4}$ inch apart in the string.

Like cigar tobacco, cigarette tobacco should be thoroughly ripe at harvesting. That is the usual signs of ripening should be carefully noted, notably the gradual discoloration from the original green to lighter or yellower hue.

Curing and curing barns.—Curing is the most important feature of bright yellow cigarette tobacco production. In 1902, Whitney (24) stated that the leaves should be cured in three days and that there are three stages in the process of curing; namely, (1) yellowing stage, (2) thorough leaf curing stage, and (3) stalk curing stage; and that because of the reduced time required, the curing barn is heated through the use of flues. The fresh leaves are brought immediately into the barn which is simultaneously heated. The first stage requires from 27° C. to 32° C. and is thus maintained until all the leaves have yellowed. At this point "the heat is raised 3° C. or 6° C. per hour at a time and held at each stage for one or two hours, until it has attained a temperature of 46° C. or 49° C. where it is held for several hours until the leaf is thoroughly cured. After this the stalk has to be cured by raising the temperature to 71° C. or 89° C. by stages of 3° C. or 6° C. per hour (depending upon prevailing weather conditions), and the temperature kept at this point until the stalk is thoroughly cured." Garner (8) and Mathewson (12), however, more recently established 27° C. to 49° C. as the range of temperature during the yellowing stage. An intermediate stage from 49° C. to 55° C. or 58° C. is further provided and kept stationary at the maximum limit until all the leaves are entirely dry, care being taken, however, that the raising of the temperature from 49° C. to 58° C. is at the rate of 1 to 1½ degrees per hour. Except for these points, the principles to be observed are identical with that of Whitney.

Only a year ago Shaw and Ram (22) succeeded in producing and curing cigarette tobacco in India by using an American variety (Adcok) and the American flue method. It was not necessary for them, however, to extend the American maximum, of 175° F. (79.4° C.) for they were satisfied with 150° F. (65.6° C.) only.

It is thus clear that the underlying principle governing satisfactory curing of cigarette tobacco is controlled, rapid but grad-

ual drying of the leaves. And obviously to attain this end, there must be a special curing barn so constructed as to insure the observance of this principle. The requisites of this curing barn are obviously also as follows:

It must not be so large as to render the uniform distribution of heat impossible nor so small as to cause unnecessary over-heating and over-consumption of fuel.

2. It must be made of materials such as wood or brick that do not readily radiate heat so that the temperature inside will not be influenced by external factors.

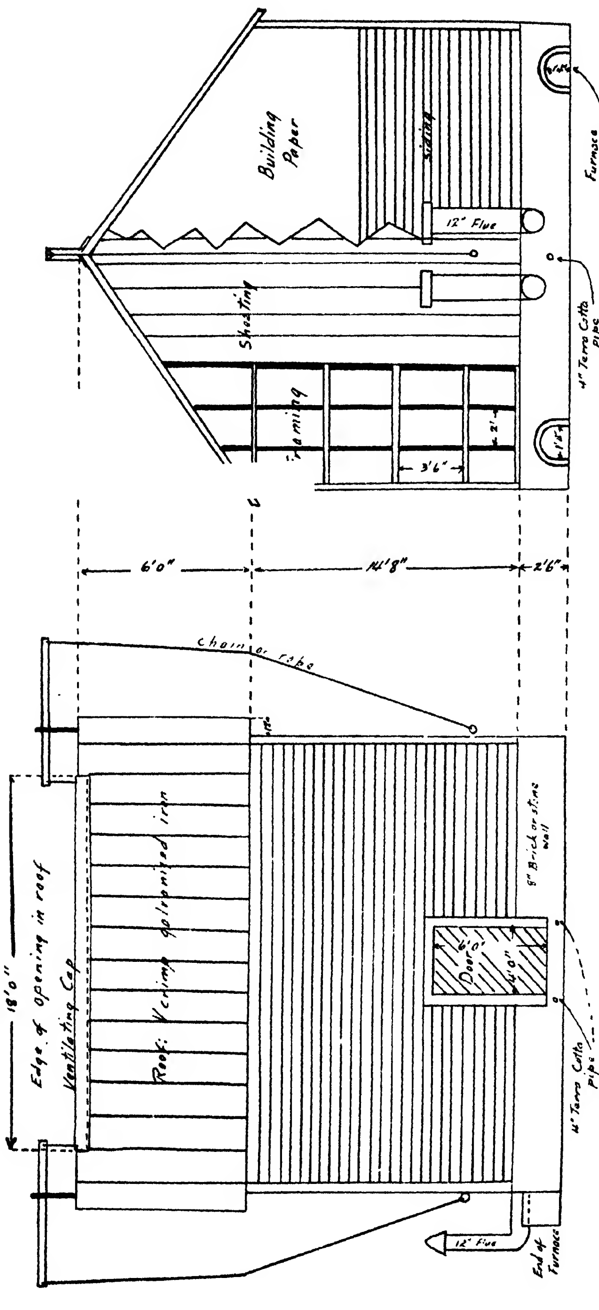
3. The building must have air-tight walls and provided with a ventilation system that is under control.

4. The heating system must also be readily controllable and the circulating heat dry in itself; hence the use of flues.

Figures 1 and 2 are reproduced from a North Carolina Agricultural Extension Service Circular by Moss(18) to show the reader the proper method of constructing and heating a model cigarette tobacco curing barn. In this connection, it is noteworthy that North Carolina is now the leading cigarette producing state in America. (The bill of materials for the same need not be considered here because obviously Philippine conditions are different.) As may be noted in the drawings the frame of the barn is 22 feet by 22 feet and 14 feet high, which gives a capacity of from 800 to 1,000 sticks of cut tobacco. And the barn is so designed as to insure a maximum economy in the consumption of fuel. Johnson(10) recommends the use of a single furnace for a 16 by 16 by 16-foot curing barn but according to Digges(6) this has a greater fire-risk than the twin furnaces. As other valuable conclusions were reached by Digges in connection with his experiments on heating appliances for flue-curing tobacco in Canada, his conclusions in full are quoted hereunder:

In the past, flue-curing kilns in Ontario have been equipped with twin brick furnaces using either wood or natural gas as fuel. Due to the large increase in acreage of flue-cured tobacco, and inadequate supply and increasing cost of wood and natural gas, it is necessary to find other fuels and heating appliances.

During the past four seasons, the Harrow Experimental Station has run experimental curings, using wood, coal, and fuel-oil, as fuels. The usual twin brick wood-burning furnaces, the Johnson Patent curing furnace, the Beckett-Covill single furnace, and the Canadian Oliver fuel-oil burner were compared as to efficiency and economy of operation. In addition, a system using high-pressure steam as a source of heat was devised and tested during the 1922, 1923, and 1924 curing seasons.



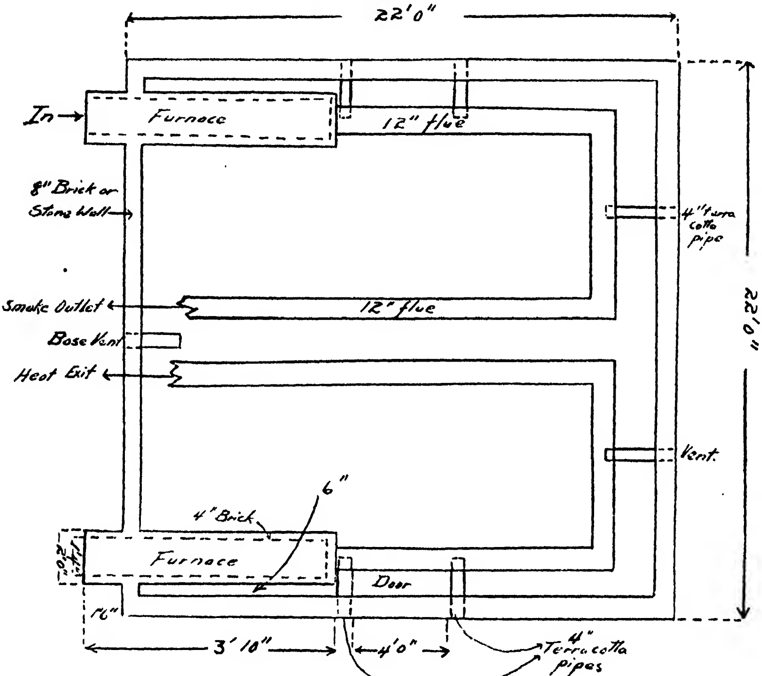
FRONT ELEVATION

END ELEVATION

FIG. 1. Front and side plan of a standard yellow tobacco (cigarette) curing barn as prepared by the Division of Agronomy, North Carolina Department of Agriculture.—*After Moss*

Single furnaces were found unsatisfactory due to their inability to distribute the heat evenly on all sides of the kiln. The fire-hazard is also greater.

Flue tobacco has been cured successfully at Harrow (Canada) for three seasons using as a source of heat high-pressure steam from a 30-horsepower, locomotive-type, portable boiler. Fuel costs have been lower with this system, and the curings more uniform. The same source of steam may be utilized for casing tobacco, sterilizing seed-beds, etc. Full data as to the economy of this method of flue-curing tobacco are not yet available, but results thus far obtained are considered favorable.



FLOOR PLAN

FIG. 2. Floor plan of a standard yellow tobacco (cigarette) curing barn as prepared by the Division of Agronomy, North Carolina Department of Agriculture.—After Moss

The scope of this paper does not permit a thorough interpretation of the phenomena involved in the curing of cigarette tobacco. Garner, Bacon, and Foubert(7) have written an exhaustive paper on the subject on curing of leaf tobacco as a whole. Suffice it to say, however, that according to Garner(8) flue curing "really consists of hastening and shortening the first stage in air curing, while the second stage of air curing, in which the brown or red color develops, is not allowed to take place at all."

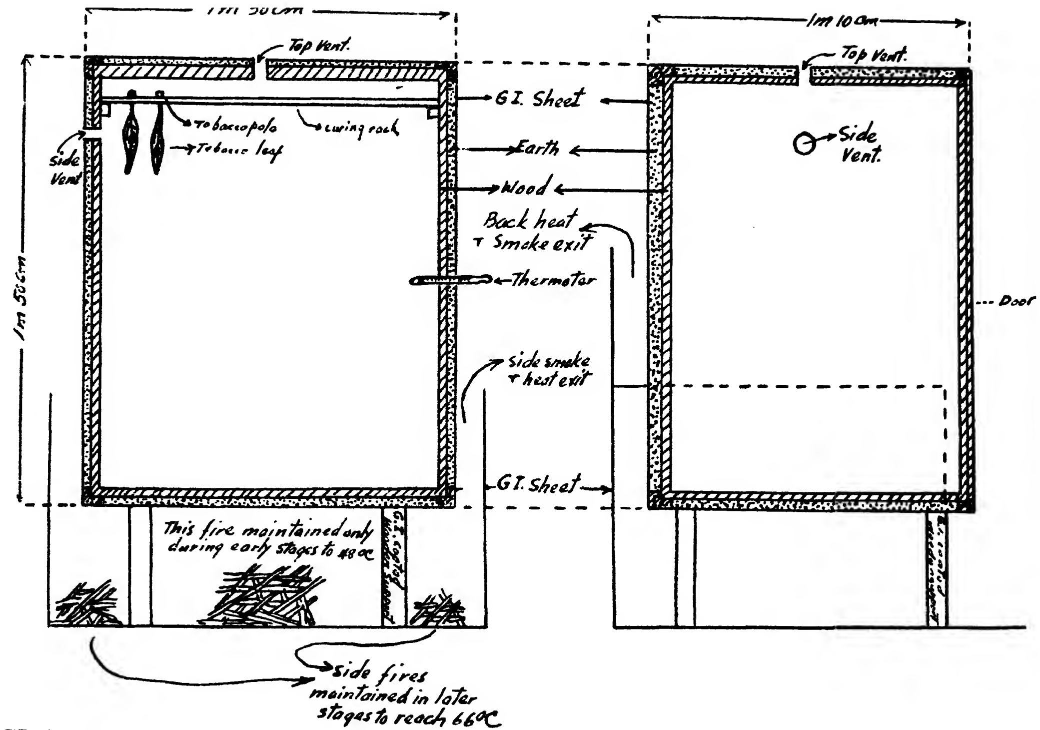
Final steps.—With regard to the fermentation, assorting and handling of yellow cigarette tobacco, Garner(8) has the following to say:

> When taken down, the tobacco is placed in bulks in shingle fashion without removal from the stocks. In order to avoid injury from mold, the bulks should be torn down at the end of a week or 10 days and rebuilt with all the butts pointing outward and the tips overlapping in the center. This treatment greatly improves the color of the leaf and especially assists in bleaching out the green remaining after the curing. It frequently happens that the contents of a barn showing a decided greenish cast will come from the bulk with a clear lemon-yellow color, provided the green has not been set by drying out the leaf too rapidly in the first stage of the curing.
>
> When the bleaching process has been completed the leaves are carefully assorted into from 6 to 10 grades, based mainly on color and freedom from holes and spots. Yellow tobacco is classified on the market into (1) wrappers, consisting of the most nearly perfect leaves; (2) cutters, being leaves deficient in body and inferior to wrappers; (3) smokers, consisting of bottom or sand leaves and others bruised or torn and lighter in body than cutters; and (4) fillers, being all tobacco not included in wrappers, cutters, or smokers. Each of these four classes is subdivided into two or more grades. The finest grade of wrappers is bright lemon yellow in color and composed of leaves free from imperfections and possessing sufficient toughness and elasticity. The next best grade is orange yellow in color, and then comes the light reddish brown grade, known as mahogany wrappers.
>
> Market prices are greatly influenced by the care and skill used in grading yellow tobacco, and this work requires experience and the ability on the part of the assorter to classify colors accurately. Each grade is tied into small bunches, or hands, and the leaf is then ready for market. In recent years much of the tobacco in the eastern section has been sold as loose leaf, without grading.

THE EXPERIMENTS CONDUCTED

The experiments conducted at the Ilagan Tobacco Experiment Station with special reference to the production of yellow cigarette leaf tobacco were begun in the season of 1925–1926, when the importation of cigarettes became more important than that of wrapper leaf. As the appropriation was small and the production of local cigar wrappers was then our major project, the experiments were naturally very limited in their scope. On the basis, however, of the general considerations already set forth, the results obtained to date are nevertheless ample for immediate reference to anyone wishing to venture into the field of cigarette tobacco production in the Philippines, particularly in the Cagayan Valley.

Soil used.—The land used in the experiments is old but uniform as to topography. And an analysis of the soil made at



FRONT ELEVATION

SIDE ELEVATION

FIG. 3. Showing the details of the construction and operation of the Ilagan Tobacco Experiment Station curing box constructed on the principles governing flue curing of yellow or cigarette tobacco.

the beginning of the experiments showed that for all the principal plant food elements, it could still be considered as of a little above normal in fertility.[1] During the progress of the experiments no attempt was made to regularly fertilize the land. But in order that it might not be too much depleted of its fertility in the progress of the experiments, it was always cover-cropped with native legumes after each tobacco crop besides being top-dressed with a liberal amount of tobacco trash during the off-season period in 1927 and tobacco ash only the following year. Lime was also applied twice at the rate of 1,000 pounds per hectare during the 1926–1927 and 1928–1929 seasons.

Tables I and II give the original analysis of the soil used at the beginning of the experiments.

TABLE I.—*Mechanical analysis of field B, lot 2, Ilagan Tobacco Experiment Station, in 1925 (water-free basis):*

Detritus not passing	0.0
Coarse sand	0.0
Medium sand	0.1
Fine sand	3.8
Very fine sand	8.6
Silt	76.4
Clay	11.1
Total	100.0

TABLE II.—*Chemical analysis of field B, lot 2, Ilagan Tobacco Experiment Station, in 1925 (water-free basis):*

Loss on ignition	9.11
Nitrogen (N_2)	0.081
Phosphoric anhydride (P_2O_5)	0.181
Lime (CaO)	2.08
Potash (K_2O)	0.468
Humus	0.35
Soil acidity ($CaCO_3$)	0.007

According to the soils standard of the United States Department of Agriculture, it is clear from Table I that our soil is classified as silty loam but bordering on clay loam.

Climatic conditions.—The weather conditions at the Ilagan Tobacco Experiment Station during the four seasons in which the experiments were conducted are itemized in Table III.

[1] According to "Practical Rating of Soils by Plant Food Percentages" by Prof. Maereker, Halle Station, Germany.

TABLE III.—*Mean monthly temperature and precipitation at the Ilagan Tobacco Experiment Station during the tobacco seasons from 1925–26 to 1928–29, inclusive.*

Months	Seasons 1925–1926 Temperature	Rainfall	1926–1927 Temperature	Rainfall	1927–1928 Temperature	Rainfall	1928–1929 Temperature	Rainfall
	°C.	mm.	°C.	mm.	°C.	mm.	°C.	mm.
October	23.51	123.7	26.87	211.8	26.58	351.5	26.04	288.8
November	23.61	104.9	25.04	365.5	25.70	137.5	25.31	461.4
December	20.10	60.04	23.09	178.7	23.18	56.6	24.51	62.9
January	23.58	89.90	23.62	88.3	23.60	102.8	23.58	64.4
February	24.44	64.40	23.74	9.9	32.85	98.5	25.70	7.5
March	26.36	19.80	24.31	19.1	24.79	18.2	25.31	50.5

The seed-bed period as a rule cover the first three months—October, November, and December—and the field period the last three months—January, February, and March.

Variety tests.—The comparative tests of the cigarette tobacco varieties were actually begun during the 1925–1926 season after the standardization had been effected of all the tobacco varieties represented in the station cultures from the beginning and resulted in these varieties being grouped as belonging to the ciggarette type; namely, 8741–15–Romero, 8726–290–Orinoco, and 8731–52–Vizcaya. The first and last are native, while the second was obtained in 1921 from Mr. Olsen of Manila, which accounts for the fact that for some time this variety was called after Mr. Olsen until it was definitely established that it was really one of the several types of the Orinoco variety of American origin.

Table IV gives a summary of the field as well as the cured leaf data obtained from the three varieties during the four seasons, from 1925 to 1929, inclusive, that they have been tested. Note that the 8731–52–Vizcaya leads in yield although the 8726–29–Orinoco possesses the best burning quality. It must be borne in mind, however, that inasmuch as the tests were comparative, the plants in the field were uniformly set out 70 centimeters apart in rows 80 centimeters apart, irrespective of the smaller size of any variety included in the tests. Topping was not done either and the curing, except in the care of those leaves used in the curing experiments proper, was done by the natural

and gradual method entirely in the station model curing shed that was especially built for cigar wrapper tobacco.

TABLE IV.—*Cigarette tobacco varieties tested during four seasons at the Ilagan Tobacco Experiment Station, 1925–1929*

P. I. No.	Station No.	Variety name	Stalk characters: Average total height	Stalk characters: Average middle circumference	Stalk characters: Average middle internode length
			cms.	*cms.*	*cms.*
8741	15	Romero	127.69	5.34	6.40
8726	29	Orinoco	100.57	5.75	4.25
8731	52	Vizcaya	188.04	7.51	5.81

P. I. No.	Station No.	Variety name	Green leaf characters: Average number standard leaves	Green leaf characters: Dimensions of middle standard: Average length	Green leaf characters: Dimensions of middle standard: Average width	Green leaf characters: Average breadth index	Cured leaf: Burning quality [a]	Cured leaf: Average yield per hectare
				cms.	*cms.*	*Per cent*	*Second*	*Kilos*
8741	15	Romero	15.02	38.06	21.98	56.47	24.98	597.13
8726	29	Orinoco	23.87	43.05	16.91	40.09	62.24	861.42
8731	52	Vizcaya	24.72	52.44	26.54	49.56	35.70	1,159.60

[a] Duration of glow after the leaf is ignited

Acclimatization tests.—Although it is believed certain that the nineteen cigarette tobacco varieties being tested for acclimatization at the Ilagan Tobacco Experiment Station really represent only four distinct varieties; namely, the Orinoco, White Burley, Petiolate Turkish, and Sessile Turkish, in view of the obvious variability still manifest in their growth and the greater opportunity for selection afforded because of the greater number of types and subvarieties available, the original names have been retained and every one considered as a distinct variety in the meantime. And because these varieties have been received at different times, the acclimatization test is subdivided according to the number of seasons each group is being tested. As a result there are two varieties tested for three seasons, ten varieties for two seasons, and seven varieties for one season only. In Table V, are given the names of the exotic varieties, their sources and the season they were tested at the Ilagan Tobacco Experiment Station for the first time.

TABLE V.—*List of cigarette tobacco varieties introduced at the Ilagan Tobacco Experiment Station from foreign countries*

P. I. No.	Station No.	Variety name	Origin	Date received	First season
9085	76	Kavalha	Rhodesia, South Africa	1- 2-26	1926-27
9112	78	Manyleaf Soulouk	Muldersvlei, South Africa	1- 2-26	1926-27
9520	108	Judy's pride	South Boston, Virginia, U. S. A.	8- 9-27	1927-28
9524	104	Adcock	do	8- 9-27	1927-28
9523	106	Longleaf Gooch	do	8- 9-27	1927-28
9526	102	Virginia Dark	do	8- 9-27	1927-28
9525	101	Virginia Bright	do	8- 9-27	1927-28
9521	107	North Carolina Bright Yellow	do	8- 9-27	1927-28
9527	105	White Stem Orinoco	do	8- 9-27	1927-28
9519	103	Goldleaf	do	8- 9-27	1927-28
9528	114	Picket's White Burley	Vanceburg, Va., U. S. A.	9- 9-27	1927-28
9518	100	Smetzger's White Burley	Higginsport, Ohio, U. S. A.	8- 1-27	1927-28
9529	112	Yellow Twist Bud	Vanceburg, Va., U. S. A.	9- 9-27	1927-28
9527	115	White Twist Bud	do	9- 9-27	1927-28
9530	113	Red Burley	do	9- 9-27	1927-28
9532	118	Judy Kelly White Burley	Midway, Ky., U. S. A.	9-14-27	1927-28
9531	117	Stand Up White Burley	do	9-14-27	1927-28
	130	Samsun-Bafra	Constanople, Turkey	5- 6-28	1928-29
	131	Turkish	Washington, D. C., U. S. A.	5- 6-28	1928-29

In Table VI it can be seen that only two varieties have been tested for three seasons and that both are Turkish in origin. Table VII shows that ten varieties have been tested for two seasons, and that all of them are American. Table VIII lists seven varieties as having been tested during the only one season, five being American and the other two Turkish in origin. The five American varieties were really cultured for the first time during the 1927–1928 season, and appreciably good stands were obtained from them with the result that complete field and cured leaf data became available. Last season, however, either because of the late planting occasioned by the big flood in November, 1928, or because they are slow in adapting themselves to the Isabela climate, their respective stands were poor and they even refused to seed. The final result is that for the 1929–1930 season, we shall be obliged to sow the rest of the seeds obtained during the 1927–1928 season in an effort to have these varieties again represented in the station cultures. Otherwise all the varieties listed in Tables VI, VII, and VIII and in the process of acclimatization at the Ilagan Tobacco Experiment Station are doing well in spite of the forced late planting last season. Notable in their performance are 9524–104–Adcock, 9528–114–Pickett's White Burley, and 9521–107–North Carolina Bright Yellow. The Turkish varieties are doing extraordinarily well but their generally small size will always be a strong deterrent to adoption by the farmers. Furthermore, their aroma so far has not been any better than that produced by the more aromatic bigger varieties.

TABLE VI.—*Cigarette tobacco varieties tested during three seasons at the Ilagan Tobacco Experiment Station, 1926–1929*

P. I. No.	Station No.	Variety name	Stalk characters: Average total height	Stalk characters: Average middle circumference	Stalk characters: Average middle internode length	Stalk characters: Average number standard leaves	Green leaf characters: Dimensions of middle standard: Average length	Green leaf characters: Dimensions of middle standard: Average width	Green leaf characters: Average breadth index	Cured leaf: Burning quality [1]	Cured leaf: Average yield per Ha.
			cms.	*cms.*	*cms.*		*cms.*	*cms.*	*Per cent*	*sec.*	*Kilos*
9085	76	Kavalha	136.58	5.15	4.18	30.75	25.99	15.61	56.14	18.37	452.9
9112	78	South African (Many leaf Soulouk)	115.88	3.95	3.13	31.94	24.88	11.87	52.80	15.36	695.75

[1] Duration of glow after leaf is ignited.

TABLE VII.—*Cigarette tobacco varieties tested during two seasons at the Ilagan Tobacco Experiment Station, 1927–1929*

P. I. No.	Station No.	Variety name	Stalk characters: Average total height	Stalk characters: Average middle circumference	Stalk characters: Average middle internode length	Stalk characters: Average number standard leaves	Green leaf characters: Dimensions of middle standard: Average length	Green leaf characters: Dimensions of middle standard: Average width	Green leaf characters: Average breadth index	Cured leaf: Burning quality [1]	Cured leaf: Average yield per Ha.
			cms.	*cms.*	*cms.*		*cms.*	*cms.*	*Per cent*	*sec.*	*Kilos*
9520	108	Judy's Pride	91.07	2.79	6.32	16.00	40.84	19.97	47.33	18.72	590.00
9528	114	Picket's W. Burley	95.93	4.52	5.60	19.40	44.97	20.53	45.09	11.95	782.50
9529	112	Yellow Twist Bud	103.81	4.89	5.40	17.76	44.15	22.23	52.95	25.20	411.87
9524	104	Adcock	119.50	5.07	4.37	21.78	44.25	21.57	47.66	16.33	1,215.62
9523	106	Longleaf Gooch	98.31	3.76	4.38	16.00	40.09	18.47	46.01	48.12	294.68
9526	102	Virginia Dark	101.02	4.58	4.13	16.73	41.03	17.93	49.41	34.46	399.05
9518	100	Smetzgers W. Burley	76.53	4.29	5.10	15.60	40.51	18.65	46.72	15.12	286.87
9522	105	W. Stem Orinoco	95.00	4.77	4.72	17.90	43.15	20.40	49.83	28.83	592.90
9525	101	Virginia Bright	78.00	4.93	4.90	16.72	41.79	14.28	36.94	72.41	617.75
9521	107	N. C. B. Yellow	95.40	5.16	5.67	18.30	46.50	28.16	58.90	23.69	636.25

[1] Duration of glow after leaf is ignited.

TABLE VIII.—*Cigarette tobacco varieties tested during one season at the Ilagan Tobacco Experiment Station*

A. VARIETIES TESTED DURING 1927–1928 SEASON[1]

P. I. No.	Station No.	Variety name	Stalk characters: Average total height	Stalk characters: Average middle circumference	Stalk characters: Average middle internode length	Green leaf characters: Average number standard leaves	Green leaf characters: Dimensions of middle standard: Average length	Green leaf characters: Dimensions of middle standard: Average width	Green leaf characters: Average breadth index	Cured leaf: Burning quality[2]	Cured leaf: Average yield per Ha.
			cms.	*cms.*	*cms.*		*cms.*	*cms.*	*Per cent*	*sec.*	*Kilos*
9519	103	Goldleaf	166.20	5.00	5.70	17.0	45.30	19.80	43.11	25.88	532.5
9530	113	Red Burley	118.60	3.04	8.34	23.8	51.10	29.84	58.36	13.64	710.0
9532	118	Judy Kelly W. B.	94.96	3.32	7 62	22.8	55.16	22.38	48.26	26.64	479.2
9527	115	White Twist Bud	119.65	2.86	8.45	24.5	48.27	21.96	45.28	14.64	1,065.0
9531	117	Stand Up E. B.	103.26	3.30	8.02	18.4	43.12	26.14	60.39	31.45	710.0

B. VARIETIES TESTED DURING 1928–1929 SEASON[3]

P. I. No.	Station No.	Variety name	Average total height	Average middle circumference	Average middle internode length	Average number standard leaves	Average length	Average width	Average breadth index	Burning quality	Average yield per Ha.
	130	Samsun Baffra	100.00	4.06	2.44	23.80	22.94	12.10	57.04	17.00	468.7
	131	Turkish	114.00	4.80	3.92	23.53	30.71	16.41	53.61	15.00	551.7

[1] The varieties under this series did not thrive normally during the second season of their acclimatization owing to lateness of planting as occasioned by the big flood of November, 1928. Hence no data were taken.

[2] Duration of glow after leaf is ignited.

[3] The last two varieties were received only in time for the last season, 1928–1929. Hence they have been tested actually only once.

The field as well as the curing treatments given all varieties under acclimatization, for comparative reasons also, is the same as that described under variety tests. That is, with the exception also of some leaves that were used in the curing experiment proper.

Identification of the cigarette tobacco varieties mentioned in the variety and acclimatization tests.—For the purpose of aiding the reader in the identification of the twenty-two cigarette tobacco varieties included in the collection of the Ilagan Tobacco Experiment Station, a simple analytical key has been prepared as likely to be more easily understood than the usually monotonous and tedious litanic descriptions. The key follows:

A simple analytical key for the identification of cigarette tobacco varieties available at the Ilagan Tobacco Experiment Station

A. Leaves petiolate .... B
  B. Leaves medium-sized, cordate, few horizontal position 8741–15–*Romero*
  B. Leaves small, ovate, erect, many 130–*Samsun-Bafra*
A. Leaves sessile C
  C. Plants small, cylindrical shaped, leaves small, erect, numerous .... D
    D. Leaves broadly alate .... E
      E. Leaves elliptical, apex rather protracted, broad 131–*Turkish*
      E. Leaf apex decidedly acute 9085–76–*Kavalha*
    D. Leaves medium alate, somewhat abovate-9112-78-*Manyleaf Soulouk*
  C. Plants medium to big, conical shape .... F
    F. Plants very big: leaves broad, elliptical, erect and apex somewhat acute 8731–52–*Vizcaya*
    F. Plants medium in size .... G
      G. Leaves decidedly chlorotic or white in the field (White Burley group) .... H
        H. Leaves decidedly erect .... 9531–117–*Stand Up White Burley*
        H. Leaves horizontal I
          I. Bud slightly twisted .... J
            J. Decidedly chlorotic leaves .... 9527–115–*White Twist Bud*
            J. Less chlorotic leaves .... 9529–112–*Yellow Twist Bud*
          I. Buds normally upright .... K
            K. Leaves less chlorotic .... 9530–113–*Red Burley*
            K. Leaves decidedly chlorotic L
              L. All leaves horizontal .... 9532–118–*Judy Kelly–White Burley*

L. Upper leaves erect, lower horizontal .... M
M. Top leaves very narrow .. 9518–100–*Smetzger's White Burley*
M. Top leaves elliptical, medium in width 9528–114–*Pickett's White Burley*
G. Leaves mostly erect, decidedly green to deep green in the field (Orinoco group) .... N
N. Leaves decidedly erect .... O
O. Leaves lanceloate 8726–290–*Orinoco*
O. Leaves broad, ovate .... 9520–108–*Judy's Pride*
N. Leaves horizontal to drooping .... P
P. Leaves decidedly drooping .... 9523–106–*Longleaf Gooch*
P. Leaves horizontal .... Q
Q. Leaves lanceolate .. 9525–101–*Virginia Bright*
Q. Leaves elliptical or ovate .... R
R. Leaves long, elliptical, slightly alate 9524–104–*Adcock*
R. Leaves ovate .... S
S. Plants tall.... 9519–103–*Goldleaf*
S. Plants medium .... T
T. Leaves medium in width.. 9521–107–*North Carolina Bright Yellow*
T. Leaves broad .... U
U. Leaves almost cordate, slightly alate and acute apex .... 9522–105–*White Stem Orinoco*
U. Leaves liberally alate, apex acuminate .... 9526–102–*Virginia Dark*

Hybridization.—In an attempt to produce new types of light colored and at the same time aromatic tobacco leaves, two crosses were included in the general hybridization work on tobacco being conducted at the Ilagan Tobacco Experiment Station in the 1925–1926 season, before seeds of the White Burleys as well as the Orinocos were received. The crosses made were as follows:

Hybrid No. 1 from 43–Philippine Sumatra x 15–Romero.
Hybrid No. 2 from 10–Repollo x 15–Romero.

The aim from the first was to combine if possible the considerable number of leaves as well as the light color of the leaves of the 43–Philippine Sumatra with the good bodied and aromatic leaves of the 15–Romero. It should be noted in this connection that the 43–Philippine Sumatra is typically a wrapper variety. The other object was somewhat different inasmuch as

size of leaf was the main factor. That is, a combination of the great length, light color and considerable number of leaves of the 10–Repollo with the aromatic leaves of the 15–Romero was sought. The four varieties used in this hybridization work are shown in the plates at the end of this article.

The 15–Romero and 10–Repollo are native varieties, while the 43–Philippine Sumatra is of exotic origin. All of them have been rigidly inbred by covering the seed heads with Manila paper bags during at least three seasons before they are used for hybridization work. The following description give the characteristics of the three varieties:

(1) 15–Romero is a native variety of small to medium size and produces 14 to 18 horizontal to drooping petiolate leaves; cordate and broad having a breadth index as high as 56 per cent; the middle standard measures 36 to 39 centimeters in length and 18 to 22 centimeters in width. The veins are medium to coarse. Its yield varies from 500 to 800 kilos per hectare. The leaves cure dark normally but are very aromatic.

(2) 10–Repollo is also a native variety of the filler type of medium size but tall and high yielding 24 to 29 erect, broadly alate and sessile standard leaves; oblong elliptical with a breadth index of from 42 to 50 per cent; medium to large in size, the middle standard being from 60 to 70 centimeters in length and 29 to 35 centimeters in width. The veins are medium and the yield varies from 1,600 to 1,900 kilos per hectare. It is hardy and therefore suitable for poorer soils and late plantings. The leaves cure light brown normally but are virtually neutral as to aroma.

(3) 46–Philippine Sumatra is the ideal wrapper cigar variety producing from 18 to 22 erect to horizontal, medium alate and sessile standard leaves that are elliptically rounded with a breadth index of around 63 per cent; small to medium in size, the middle standard measuring from 46 to 50 centimeters in length and 28 to 32 centimeters in width. The veins are very fine to fine. It has a slender but relatively tall stalk. The yield varies from 1,000 to 1,200 kilos per hectare. The leaves cure light to mousy brown normally with an almost neutral aroma.

This article being primarily agronomic, the methods used in tobacco hybridization partly described need not be explained in detail. Suffice it that they were standard for tobacco. And because the objective in either case, that is, in effecting cross or

hybrid No. 1 and cross or hybrid No. 2, was purely commercial, only such phases of the work as have a bearing upon the objective will be further taken up under this topic. The purely technical phases will be dealt with in full when the work on tobacco breeding as a whole at the Ilagan Tobacco Experiment Station is reported, which will be in the near future.

Both hybrids No. 1 and 2 have been carried through the second generation. On the whole the first generation hybrids with regard to quantitative characters, like the total plan height, leaf length, leaf width, leaf breadth index, middle internode length and middle stalk circumference, were all virtually intermediate between either parents although in many instances, they were closer to the bigger sizes, due presumably to the phenomenom of *heterosis*. For the present purpose, Tables XI and X are presented herewith to furnish typical illustrations of the inheritance of quantitative characters in either crosses. For cross No. 1, inasmuch as the number of standard leaves is the outstanding contrasted quantitative character, this is taken as an example and for cross No. 2, for like reason—the leaf breadth index is the example.

With respect to leaf qualitative characters, it is readily to be noted that while the alation of the petiole is apparently intermediate and therefore quantitatively inherited in the first generation hybrids, the well defined petiolate leaf base of the 15–Romero appears to be an independent and dominant character. The dark cured leaf color and heavier body of the 15–Romero appear also be dominants over their respective allelomorphs.

In Tables IX and X can also be noted the extreme uniformity of the first generation hybrids because of intimate fusion of the genetic factors, whereas in the second generation, the plants are extremely variable because of the subsequent segregation or dissociation of the same genetic factors. These occurrences with regard to quantitative characters are also applicable to qualitative characters. For instance, in the case of the first generation petiolate character, this segregated into a ratio of 7 to 3 in the second generation, which ratio therefore may be considered as virtually simple mendelian, that is, 3 to 1.

It is the object or hybridization to create maximum variation thereby supplying materials for new selections. And because this stage reaches its peak in the second generation of hybrids, this becomes automatically the real beginning of the work on selection for entirely new desirable types. In this respect

we were more fortunate at the station in the case of the second cross or hybrid No. 2. Indeed in hybrid No. 2–6–12 which becomes I. T. E. S. Hybrid No. 2F3–6–12 in the 1929–1930 season, we seem to have found an ideal compromise or combination of the best qualities of both the 15–Romero and the 10–Repollo. The total height of the plant is 210 centimeters; the middle standard leaf is 60 centimeters long and 29 centimeters wide, petiolate, ovate, horizontal to drooping. The total number of standard leaves is 25, curing light brown normally, smooth and aromatic.

Although not a single promising type was obtained from the second generation of hybrid No. 1, subsequent selections will be continued just the same, if for no other reason than the purely technical.

Liming observation.—As previously stated that the field used in the cigarette tobacco experiments was lime twice at the rate of 1,000 pounds per hectare during the 1926–1927 and 1928–1929 seasons. Because, however, the main objective in cigarette tobacco production is quality rather than yield, the effect of liming was primarily observed with reference to the color, aroma and body of the leaves produced. The experiment on the application of lime at different rates to really determine the optimum lime requirement of cigarette tobacco was conducted only once so no definite conclusions can be drawn. Nevertheless the moderate application made, judging by the lighter color, good aroma and good body of the leaves resulting, was sufficient indication that a moderate application of lime on Isabela silty loam soils of normal fertility is good for cigarette tobacco. Curiously enough the same thing holds true for both cigar filler and cigar wrapper tobacco.

TABLE IX.—*Frequency distribution of standard leaves per plant in cross between 15-Romero and 43-Philippine Sumatra*

Station numter and variety name	Class centers for number of standard leaves										Total
	14	16	18	20	22	24	26	28	30	32	
43–Philippine Sumatra					5	3	6	4	2	....	20
15–Romero		2	7	6							15
(43×15) F_1				5	2	5	1	2			15
(48×15) F_2	1	2	2	9	1	3	1	0	1	....	20

Station number and variety name	Mean	Standard deviation	Coefficient of variability
48–Philippine Sumatra	25.50–0.391	2.60–0.227	10.19–1.198
15–Romero	18.53–0.236	1.36–0.167	7.32–0.902
(43×15) F_1	23.07–0.475	2.72–0.336	11.81–1.473
(48×15) F_2	24.70–1.272	8.44–0.901	34.17–4.065

TABLE X.—*Frequency distribution of breadth index of leaves in cross between 15–Romero and 10–Repollo*

Station number and variety name	Class center for breadth index of leaves									Total
	38	43	48	53	58	63	68	73	78	
15–Romero		1	2	5	7					15
10–Repollo	3	11	9	1	1					25
(10×15) F_1			6	10	2	2				20
(10×15) F_2		3	16	6	5	1	3	0	1	35

Station number and variety name	Mean	Standard deviation	Coefficient of variability
15–Romero	53.50±0.792	4.55±0.559	8.50±1.047
10–Repollo	44.70±0.603	4.47±0.426	10.00±0.954
(10×15) F_1	52.50±0.893	4.29±0.459	8.16±0.878
(10×15) F_2	52.36±0.909	7.98±0.644	15.24±1.207

Topping test.—Gross-topping tests were conducted recently using the 52–Vizcaya and the 131–Turkish varieties, the first representing the bigger group and the second the smaller. The results of the test are summarized in Table XI.

TABLE XI.—*Some effects of topping on cigarette tobacco (cured stage)*

Variety	Extend of topping	Number of plants	Average leaf thickness	Aroma	Predominant leaf color	Average burning quality [1]
			mm.			*sec.*
52–Vizcaya	Untopped (check)	25	.09	Good	Light brown	76
	⅓ removed	25	.11	Good	Light brown	61
	½ removed	25	.13	Good	Brown	67
131–Turkish	Untopped (check)	25	.11	Fair	Brown	15
	⅓ removed	25	.14	Good	Brown	17
	½ removed	25	.15	Good	Dark brown	11

[1] Duration of glow after the leaf is ignited.

From the foregoing it is quite evident that moderate topping is good for cigarette tobacco. If we take the Virginia leaf as a model in body, curiously enough we find its thickness in the cured stage is 0.11 millimeter, the same as the 52–Vizcaya when moderately topped. None of the leaves were yellow because in this test they were subjected to the slow natural curing completely in the shed.

Yield and quality as affected by the seasons.—It is interesting to note how the seasons affect the yield of the two cigarette

tobacco varieties, 52–Vizcaya and 15–Romero from the beginning of the variety tests in the 1925–1926 season. The results are given in Table XII.

TABLE XII.—*Some effects of the seasons upon the yield and gross quality of cigarette tobacco (cured stage)*

Variety	Season	Months in field	Total 3-month rainfall	Average yield per hectare	Gross quality (aroma, color and body)
			mm.	*Kilos*	
	1925-26	Dec., Jan., Feb.	214.34	1,201.0	Fair.
52–Vizcaya	1926-27	Jan., Feb., Mar.	117.30	1,092.0	Good.
	1927-28	Dec., Jan., Feb.	157.90	1,115.0	Fair.
	1928-29	Jan., Feb., Mar.	122.40	1,230.0	Very good.
	1925-26	Dec., Jan., Feb.	214.34	658.7	Fair.
15–Romero	1926-27	do.	276.09	868.3	Good.
	1927 28	do.	257.90	849.0	Fair.
	1928-29	Jan., Feb., Mar.	122.40	312.5	Very good.

Indeed from Table XII it is almost definitely established that cigarette tobacco requires only a moderate amount of rainfall to insure its desirable qualities although that means an appreciable reduction in the yield. An allowance, however, must be made for the fact that the seasons of good qualities concided with the application of lime.

Yield and quality as affected by the soil texture.—It happened that during the season of 1923–24, the last one spent at Dammao, Gamu, the former site of the tobacco station, the 52–Vizcaya was raised on a sandy alluvial soil and as a result it yielded an average of 1,803.2 kilos of cured leaf tobacco per hectare, while the 4-year average of this same variety in the silty loam soil of the station at Ilagan is only 1,159.5 kilos. The aroma produced in the former, however, was virtually nil. And the body of the leaf was weak also.

Harvesting by cutting the whole stalk and by priming.—Using the 131-Turkish variety during the 1928–1929 season, an attempt was made to obtain some relative data on the two methods of harvesting cigarette tobacco prevailing in the United States and Turkey, namely; harvesting by priming or picking the leaves one by one as they ripen and by cutting the whole stalk. The results are shown in Table XIII.

TABLE XIII.—*Some comparisons of cured leaves of 131–Turkish harvested by priming and by cutting the stalk*

Harvesting method	Average number of leaves obtained per plant	Average yield per Ha.	Average middle standard leaf length	Average burning quality [1]	Uniformity
		Kilos	*cms.*	*sec.*	
1. Priming	23.5	551.7	30.71	15	Fair.
2. Cutting white stalk	19.00	388.6	27.00	16.4	Very irregular.
Differences in savor of priming.	4.5	163.1	3.71	—1.4	+

[1] Duration of glow after leaf is ignited.

There is no question but that priming method of harvesting is the logical way for cigarette tobacco—indeed for all types of tobacco. In countries, however, where labor is very dear or high and possibly because of a short summer period, the method of harvesting by cutting the stalk might be the only one practicable. Curiously enough while the range of the burning quality of the cut tobacco is big, the average is higher than that of the primed.

Curing test.—Re previous experiments and tests it has been repeatedly pointed out that for comparative purposes, all leaves used were cured under normal conditions, that is, by the slow, natural method in which the leaves are strung about half an inch apart on convenient poles about one meter along and hung up to dry entirely in the shade. In view, however, of repeated failures with this method to produce the coveted yellow color of the cured leaves although some of the cigarette varieties, notably the Burleys, appear outright chlorotic even in the seedbeds, a more intensive curing test proper was begun in the 1927–1928 season, for the sole object of finding a method to obtain the said color. The best obtained from the normal or natural method has been the light brown color.

The following methods of curing cigarette tobacco were tried:

1. Stringing spaced (about ½ inch apart) and curing entirely in the shade (normal or natural method or check).
2. Stringing spaced and four days preliminary sun curing—the rest of the time in the shade.
3. Stringing spaced and curing entirely in the open or completely sun curing.
4. Tight sticking (native method with *palillo*) and two to four days preliminary sun curing—the rest of the time in the shade.

5. Tight sticking and complete sun curing.

6. Tight sticking and curing entirely in the shade with controlled and gradually raised heat to 66° C.

7. Stringing spaced and curing entirely in the shade with controlled and gradually raised heat to 66° C.

The serial number given each method will serve as a code in Table XIV which summarizes the results obtained from the curing tests.

Obviously, the number of methods tried is too few. But present limited appropriations and consequently limited facilities available at the Ilagan Tobacco Experiment Station did not permit more experimentation. Even the last two methods (6 and 7) which should be practiced on the flue principles could not be followed exactly. The Turkish method could not be tried at all.

A device for use in the flue method of curing cigarette tobacco at the station consisted of a big wooden box: 1.5 meters high, 1.3 meters wide and 1.1 meters deep, the wood being 2.5 centimeters thick. The box was covered all over (except the door) with plain 24 gauge galvanized iron in such a way that a 2.5 centimeters space throughout was provided for an intermediate layer of very dry and pulverized earth. The device is simple indeed but it afforded a means to maintain constant temperatures. For instance, in the acts of refueling, without the heated earth, the temperature would invariably drop for some while. As may be observed in Fig. 3, even the application of heat is simple. During the last stages of curing, however, it was found necessary to build fires on both sides of the box to obtain temperatures up to 66° C.

Following the standard principles prevailing in the United States attending the method or practice of flue curing cigarette tobacco, the following temperatures were gradually applied from the beginning to the end of the curing process:

FIRST STAGE

First three hours	28° C.
Next three hours	30° C.
Next five hours	32° C.
Next six hours	35° C.
Next six hours	38° C.

TABLE XIV.—*Some results obtained from curing tests of leaves of representative cigarette tobacco varieties (cured leaf stage)*

Variety	Method No.	Color of leaf	Days to cure	Burning quality[1]	Aroma	Test No.
			Days	*Seconds*		
52-Vizcaya	1	Light brown	28-30	39.9	Good	25
	2	Speckled brown	12-14	52.0	Good	25
	3	Irregular	6-8	60.0	Fair	25
	4	Speckled yellow	14-16	21.2	Good	25
	5	Brown and yellow	8-10	50.1	Fair	25
	6	Green and yellow	2-1/6	13.1	Fair	10
	7	Yellow	3-4	18.1	Good	10
15-Romero	1	Dark brown	26-28	19.2	Good	25
	2	Speckled dark brown	12-14	24.0	Good	25
	3	Irregular	7-10	26.0	Fair	25
	4	Brown-yellow streaks	13-15	18.0	Good	25
	5	Dark-speckled brown	9-11	30.0	Fair	25
	6	Green-yellow streaks	2-1/6	15.7	Fair	10
	7	Greenish yellow	3-4	17.2	Good	10
114-Pickett's White Burley	1	Light brown	26-28	11.0	Good	25
	2	Speckled brown	12-14	20.1	Good	25
	3	Irregular	7-9	18.2	Fair	25
	4	Speckled yellow	14-16	14.0	Good	25
	5	Brown-yellow	9-12	20.0	Fair	25
	6	Speckled yellow	2-1/6	12.0	Fair	10
	7	Yellow	2-1/6	15.0	Good	10
29-Orinoco	1	Brown	24-26	31.3	Good	25
	2	Irregular brown	12-14	40.0	Good	25
	3	Very irregular	7-9	45.4	Fair	25
	4	Irregular yellow	12-14	20.0	Good	25
	5	Brown-yellow	8-10	43.9	Fair	25
	6	Speckled yellow	2-1/6	13.9	Fair	10
	7	Yellow	2-1/6	18.7	Good	10
30-Samsun Bafra	1	Brown	20-22	17.0	Fair	25
	2	Irregular brown	10-12	19.2	Good	25
	3	Irregular brown	6-8	19.8	Fair	25
	4	Brown	11-13	20.4	Good	25
	5	Brown-all shades	6-9	20.6	Fair	25
	6	Green-yellow streaks	2-1/6	12.5	Fair	10
	7	Greenish yellow	2-1/6	17.0	Good	10

[1] Duration of glow after leaf is ignited.

During the first stage the smaller leaves, notably the 114-White Burley and 29-Orinoco, were yellow. The native varieties were still greenish. As the box was closed air-tight, the relative humidity inside was maintained at not less than 80 per cent because of the imprisoned moisture given off by the leaves themselves.

SECOND STAGE

25th hour	39° C.
26th hour	40° C.
27th hour	41° C.
28th hour	42° C.
29th hour	43° C.
30th hour	44° C.
31st hour	45° C.
32nd hour	46° C.
33rd hour	37° C.
34th to 40th hour	48° C.

During the second stage as well as in the last one the door was partly opened and the side and top ventilators (see Fig. 3) were

also opened to maintain an absolutely dry atmosphere in the box, thereby insuring proper and quick drying of the leaves.

LAST STAGE

41st hour	48° C.
42nd hour	50° C.
43rd hour	52° C.
44th hour	54° C.
45th hour	56° C.
46th hour	58° C.
47th hour	60° C.
48th hour	62° C.
49th hour	64° C.
50th to 52nd	66° C.

At this point all the leaves were completely dried but those of 52–Vizcaya and 10–Romero were as yet too greenish to be removed. Accordingly the leaves of these two varieties were further heated for 6 hours more at the same temperature of 66° C.

It is quite clear from Table XIV that on the basis of the different methods tried for curing cigarette tobacco with the desired yellow color, the flue method or at least any method which is governed by the same principle of the flue, can alone effect it. It is nevertheless gratifying to note at the same time that the yellow color can also be obtained, although irregularly at present, from the modified native method, provided the crop is raised during a period of moderate rainfall.

Coöperative experiment.—During the last tobacco season because of late planting of tobacco in the Cagayan Valley was general on account of the big flood in November 1928, and because in consequence, the crop was produced in a period of moderate rainfall, the agricultural assistant was requested to shift a coöperative experiment on the production of filler tobacco for high yield with the use of the standard variety 12–Pampano No. 2 (Marogani) to yellow cigarette leaf tobacco, varieties 12–Pampano No. 2 and 52–Vizcaya being similar. The result was gratifying. Coöperator Santiago Bancud of Tuguegarao, Cagayan, in adopting curing method No. 4 as already described in the previous topic succeeded in producing about one quintal of yellow leaf tobacco.

TESTIMONIALS

Yellow cigarette leaf tobacco of more or less satisfactory grade can be produced in the Cagayan Valley. With reference to the tobacco produced by coöperator Santiago Bancud, the manager

of the Philippine Aromatic Cigarette Manufucturing Co., Manila, wrote the following in part on August 6, 1929:

> We have tested this small sample and are quite satisfied with the result. If you could only improve the burning quality of the same by making the leaves a little dryer, and also by making the color a little yellower, then we believe that this tobacco could be utilized in the making of very fine native or semi-American cigarettes.

With regard to yellow cigarette leaf tobacco produced at the Ilagan Tobacco Experiment Station during the recent 1928–1929 season, the Collector of Internal Revenue, Manila, on July 15, 1929, wrote in part:

> The samples are good and if large quantities of the different varieties could be produced, there might be created several new kinds of Philippine cigarettes.

SUMMARY

Because of the increasing demand for a cigarette with a yellow filler in the Philippines, the importation of this item being more than double in value that of the other only important imported tobacco product, namely cigar wrapper leaf tobacco, several experiments all focusing upon the possibility of producing locally a product equal to if not better than the imported kind, were begun in 1925, the year when the importation of cigarettes began to be appreciable or important. These experiments are still in progress.

On the whole the methods of yellow cigarette leaf tobacco production differ from those for cigar filler in three essential points only, as follows:

First. The variety to be used must inherently possess the characteristics of producing leaves with good body, good aroma, sweetish test, and that cure yellow under certain conditions.

Second. The growing period must coincide with a period of moderate rainfall. At the most during the first two months, heavy rains will not matter so much provided the last month is markedly dry.

Third. The leaves should be cured in a specially built curing barn about 6.5 x 6.5 meters and 4 meters high to the eaves. The square form and limited size will insure the uniform and effective distribution of heat inside.

In line with the foregoing, two native varieties have been standardized, nineteen foreign varieties have been or are being acclimatized, and a promising hybrid has been produced especially for cigarette tobacco production in the Philippines.

It is hoped that as the experimental work reported here is still in progress and that with more appropriations becoming available, improvements on the findings to date will be effected for the good of all concerned.

ACKNOWLEDGMENT

The writer wishes to acknowledge his obligations for valuable help and coöperation rendered by Messrs. Nemesio Hernandez and Hilario T. Maggay, farm manager and agricultural assistant respectively at the Ilagan Tobacco Experiment Station and by Ulpiano V. Madamba, agricultural assistant, formerly at the Ilagan Tobacco Experiment Station, now at the Sarunayan Tobacco Experiment Station.

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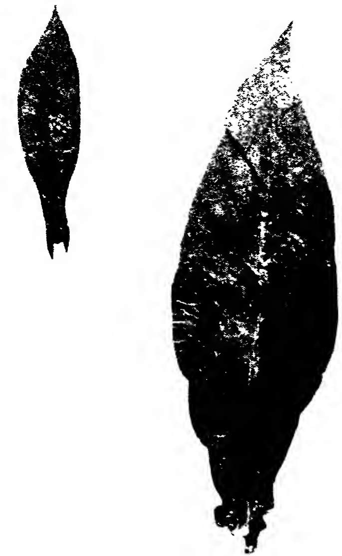
(*a*) Appearance of field after lime has been applied by hand to insure uniform application, Ilagan Tobacco Experiment Station

(*b*) The cigarette variety tests field, Ilagan Tobacco Experiment Station, season of 1928-1929

(*a*) Typical plant of the *Orinoco* tobacco variety



(*b*) Typical top and middle standard leaves of the *Orinoco* tobacco variety

PLATE III

(*a*) Typical plant of the *Mangleaf Soulouk* tobacco variety belonging to the Turkish group of four represented in the cultures of the Ilagan Tobacco Experiment Station. This and another were received three years ago, and the other two only during the last tobacco season.

(*b*) Typical top and middle standard leaves of *Mangleaf Soulouk* tobacco variety

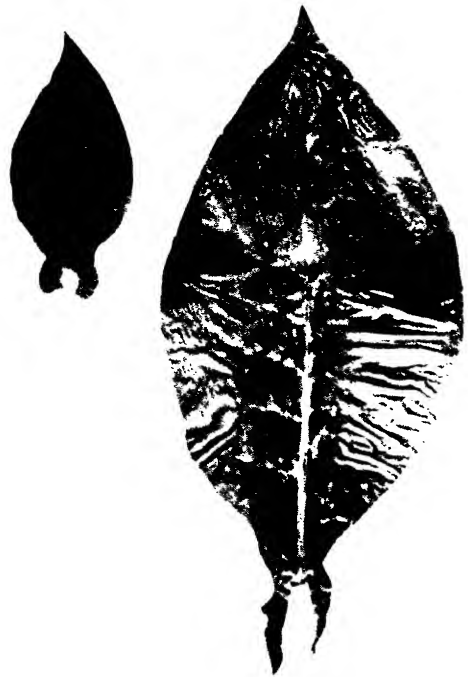
(*a*) Typical plant of the *Repollo*, a native variety of the cigar type, one of the parents of I. T. E. S. Hybrid No. 2

(*b*) Typical plant of the *Romero*, a native variety of the cigarette type, the other parents of I. T. E. S. Hybrid No. 2

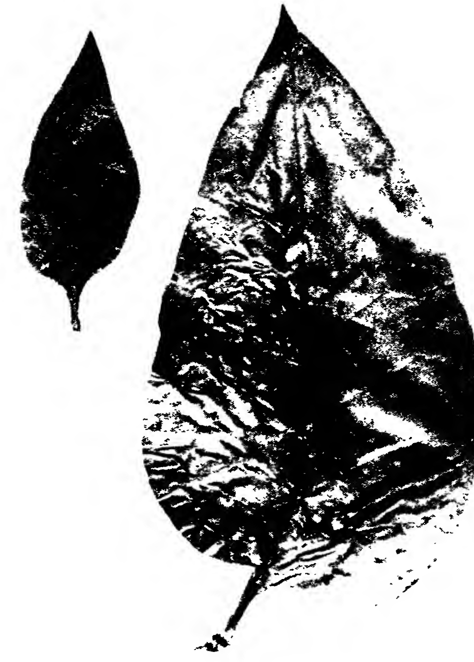
(a) I. T. E. S. Hybrid No. 2 in the first generation or Hybrid No. 2F[1]--6

(b) A most promising type or segregate of I. T. E. S. Hybrid No. 2 in the second generation or hybrid.

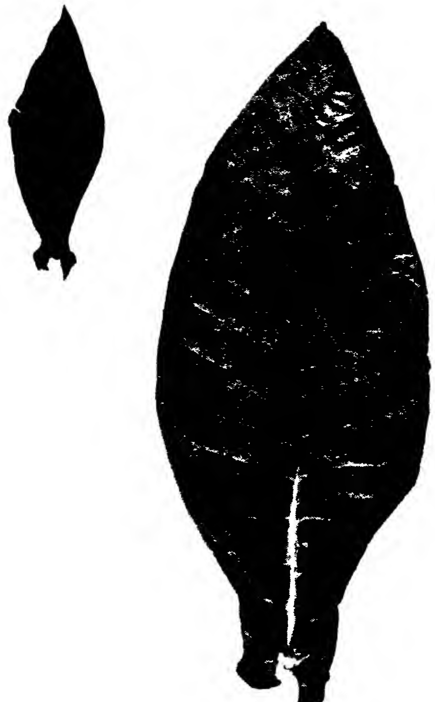
PLATE VI



(a) Philippine-Sumatra (P1), an acclimatized exotic variety producing many light coloured leaves of medium to small size



(b) Romero (P2), a native variety producing a few dark medium to small leaves also but aromatic



(a) Repollo (P[1]), a high yielding native variety producing many light colored but mild leaves

(b) Typical top and middle standard leaves of the *White Burley* tobacco variety

RÉSUMÉ OF THE ANNUAL REPORT OF THE BUREAU OF AGRICULTURE FOR THE YEAR ENDING DECEMBER 31, 1929

By STANTON YOUNGBERG
Director of Agriculture

AGRICULTURAL CONDITIONS [1]

It is most reassuring to know that notwithstanding calamities worse than any suffered for many years before by the farmers, the year under review was one of the most successful years for agriculture in the Philippines.

The rains came late for the planting of rice and corn and reduced the area planted to both cereals. A most destructive typhoon among several others of ordinary force leveled the unharvested rice and corn to the ground; bowed down thousands and thousands of coconut trees and hills of abacá and defoliated millions of them. Nevertheless the total area under cultivation during the year discussed was the largest known since 1909–10, with the exception of that for the year 1926–27, when favorable weather permitted the planting of an extraordinary area to rice and corn; though combining the area for all crops, the excess was only slight.

The losses sustained by the different crops, especially rice and corn, on account of drought were slightly greater than those experienced in the preceding year; but the injury done to all crops, particularly coconuts, abacá, and sugar cane, because of the typhoon of November, 1928, and the floods and the force of the winds, was enormous. It is estimated that the losses suffered on account of the typhoon were over ₱38,000,000. The losses sustained the year before from the same causes were estimated at ₱10,000,000.

It is feared that on account of the damage done to coconuts and abacá plantations by said typhoon, the production of both crops will be seriously curtailed for several years, unless very favorable weather conditions prevail.

[1] To conform to the crop seasons of the different products, the crop statistics given everywhere in this report are for years ending June 30.

Plant pests and diseases did less harm this year than the year before, the corresponding losses being estimated to be 0.7 and 1.0 per cent respectively of the aggregate area planted to rice, coconuts, corn, abacá, sugar cane, tobacco, and maguey.

In spite of all these troubles, the farmers generally succeeded in increasing the total area planted of their farms, raised record crops of sugar cane, coconuts, abacá, cacao and coffee and obtained the highest yield per hectare for rice, sugar and coconuts.

Prices during the year were generally lower than the year before, especially for abacá, centrifugal sugar and copra; but there was a slight advance for palay and corn and a moderate gain for tobacco.

In the following table there are given the combined areas planted to the six leading crops of the country, to wit, palay (rough rice), coconuts, corn, abacá, sugar cane, and tobacco, with their aggregate value for 1903, and from 1910 to 1929; the average value of production per capita and the average value of production per hectare.

Table II gives for 1903 and from 1910 to 1929, the total population of the Islands, the area planted to the six leading crops and the corresponding area per capita.

TABLE I

Year	Area in hectares	Value	Average value of production per capita	Average value of production per hectare
[illegible]	[illegible]			
1910	2,256,530	₱137,005.960	₱15	₱61
1911	2,148,240	152,501,510	17	71
1912	2,303,870	148,347,500	16	64
1913	2,361,480	168,633,730	18	71
1914	2,579,990	163,496,250	17	63
5-year average	2,330,022	153,996,990	17	66
1915	2,522,210	159,055,330	16	63
1916	2,531,700	179,241,380	18	71
1917	2,691,410	244,179,470	24	91
1918	2,918,590	361,940,450	35	124
1919	2,974,920	458,698,580	44	154
5-year average	2,727,766	280,623,040	28	103
1920	3,276,930	687,131,500	65	210
1921	3,515,590	403,258,250	37	115
1922	3,429,750	302,143,710	28	88
1923	3,495,440	380,194,710	34	109
1924	3,516,200	434,754,470	38	124
5-year average	3,446,782	441,496,530	40	128
1925	3,508,140	483,712,230	42	138
1926	3,573,200	478,861,060	41	135
1927	3,669,970	503,666,890	43	137
1928	3,619,430	472,584,580	40	130
1929	3,646,720	490,972,370	41	135
5-year average	3,603,490	485,959,430	41	135

TABLE II.—*Area planted in hectares*

Years	Palay	Corn	Sugar cane	Coconut	Abacá	Tobacco	Total
1903	592,766	107,980	71,885	148,245	217,810	31,417	1,170,103
1918	1,368,140	418,390	205,510	335,600	512,510	78,440	2,918,590
1919	1,381,340	430,710	200,200	373,250	515,560	73,860	2,974,920
1920	1,484,890	537,130	197,400	397,030	559,360	101,120	3,276,930
1921	1,673,380	543,830	241,340	417,960	548,090	90,980	3,515,580
1922	1,661,430	549,960	240,820	422,680	494,990	59,870	3,429,750
1923	1,675,870	557,690	227,290	456,440	513,420	64,730	3,495,440
1924	1,737,910	533,230	227,190	460,440	485,340	72,090	3,516,200
1925	1,725,500	522,380	239,470	472,050	477,110	71,630	3,508,140
1926	1,755,920	533,570	231,840	485,030	492,050	74,790	3,573,200
1927	1,807,060	561,430	237,350	500,010	480,150	83,970	3,669,970
1928	1,786,960	519,680	237,000	515,510	480,730	80,480	3,620,360
1929	1,775,460	515,040	257,710	531,040	484,850	82,620	3,646,720

NUMBER OF HECTARES PER CAPITA

Years	Population	Palay	Corn	Sugar cane	Coco-nuts	Abacá	Tobacco	Total
1903	7,636,426	.0776	.0142	.0094	.0194	.0285	.0041	.1532
1918	10,314,310	.1327	.0406	.0199	.0325	.0497	.0076	.2830
1919	10,398,029	.1328	.0414	.0193	.0359	.0496	.0071	.2861
1920	10,566,040	.1405	.0508	.0187	.0356	.0529	.0096	.3101
1921	10,734,053	.1559	.0507	.0225	.0389	.0510	.0085	.3275
1922	10,902,081	.1524	.0504	.0221	.0388	.0454	.0055	.3146
1923	11,070,306	.1514	.0504	.0205	.0412	.0464	.0058	.3157
1924	11,238,593	.1546	.0475	.0202	.0410	.0432	.0064	.3129
1925	11,406,875	.1513	.0458	.0210	.0414	.0418	.0063	.3075
1926	11,575,176	.1517	.0461	.0200	.0419	.0425	.0065	.3087
1927	11,744,172	.1539	.0478	.0202	.0426	.0409	.0071	.3125
1928	11,913,167	.1500	.0435	.0199	.0433	.0403	.0068	.3038
1929	12,082,366	.1470	.0426	.0213	.0440	.0401	.0068	.3018

Palay (rough rice).—The planting of palay was hindered in many regions because of the lateness of the rainy season. This coupled with the low prices that have prevailed in the past three years, disappointing not a few planters, caused the area planted to this chief diet of the Islands for 1928–29 to register a further decrease of one per cent of the area planted in 1927–28, which itself was one per cent, smaller than the area planted for 1926–27, the record year.

The area planted for 1928–29 was 1,775,400 hectares, as against 1,786,960 hectares in 1927–28 and 1,807,060 hectares for 1926–27.

Although the damage done by typhoons and floods was severer than the year before, the production for the year discussed was but a triple less than that for 1927–28, and scarcely half of one per cent less than that for 1926–27, the largest crop ever gathered in the Islands. The total production for 1928–29, amounted to 49,786,400 cavans of 44 kilos as against 49,921,200 cavans for 1927–28 and 49,946,400 cavans for 1926–27.

No material change was registered this year from last, regarding the proportion of land planted to upland and lowland rice, nor in the yields obtained for either kind of land. There

was more land planted to upland than to lowland rice, but the increase was only seven-tenths of one per cent while the average yields per hectare were almost the same—22.80 cavans for 1928–29 and 22.78 cavans for 1927–28.

The area planted to upland rice during 1928–29 was 558,690 hectares yielding 12,739,500 cavans. The corresponding figures for 1927–28 were 550,400 hectares and 12,540,100 cavans.

The area planted to lowland rice in 1928–29 was consequently seven-tenths of one per cent smaller than that for the preceding year, but the yield per hectare was two-tenths of one per cent greater. The hectarage planted to lowland for 1928–29 and 1927–28 was 1,216,770 and 1,236,560 hectares, respectively and the corresponding productions were 37,046,900 and 37,381,100 cavans. The respective yields per hectare were 30.45 and 30.23 cavans.

Table III gives for 1903 and from 1910 to 1929, the total area planted to rice, the total production, the average production per hectare, the average price per cavan, and the total value.

TABLE III

Years	Area cultivated	Production	Average yield per hectare	Average price per — Cavan	Average price per — Kilo	Total value
	Hectares	*Cavans*				
1903	592,770	11,465,540	19.34	(b)	(b)	(c)
1910	1,192,140	18,859,090	15.82	₱3.01	₱0.07	₱55,765,850
1911	1,043,760	20,530,100	19.67	3.01	.07	61,759,590
1912	1,078,890	11,622,470	10.77	3.44	.08	39,981,290
1913	1,141,240	24,498,860	21.47	2.37	.05	57,939,800
1914	1,244,940	22,736,810	18.26	2.52	.06	57,261,760
1915	1,130,710	17,818,490	15.76	2.76	.08	49,207,980
1916	1,140,830	20,878,860	18.30	2.68	.06	55,923,820
1917	1,225,690	28,276,720	23.07	2.85	.06	81,377,810
1918	1,368,140	35,795,050	26.16	3.77	.08	135,163,370
1919	1,381,340	33,781,650	24.45	5.58	.13	188,614,590
1920	1,484,890	36,343,810	24.47	7.01	.16	254,855,380
1921	1,673,380	41,478,540	24.79	3.78	.08	156,892,680
1922	1,661,430	43,436,830	26.14	3.22	.07	139,935,080
1923	1,675,870	43,790,500	26.13	3.40	.08	149,475,950
1924	1,737,910	41,570,700	23.92	4.20	.09	172,957,290
1925	1,725,500	45,652,600	26.46	4.20	.09	192,179,270
1926	1,755,920	47,780,000	27.21	4.27	.10	204,051,110
1927	1,807,060	49,946,400	27.64	4.02	.09	200,970,720
1928	1,786,960	49,921,200	27.94	3.67	.08	183,295,130
1929	1,775,460	49,786,400	28.00	3.88	.09	193,431,510

Coconuts.—The remarkable and steady preference that the farmers are giving to this crop seems to indicate that this product will be in the course of time the premier industry of the Islands. Year after year during the last two decades there has

been an ever larger number of trees planted, all over the entire Archipelago; and like rice the trees now are found in proportionately large numbers in almost every town of the Islands. The only season that saw a smaller number of trees planted than before was that of 1912–13 and that was because of an unusually prolonged drought of several months followed by a series of strong typhoons and floods that killed several hundred thousand trees and discouraged the farmers from planting more new trees during the year.

During the year under review there was also drought though of short duration, but the typhoon that passed over the Islands in November, 1928, was terrifically destructive especially for the coconut regions and yet the preference of the farmers for this crop survived even this, for in spite of the fact that it injured over eleven million trees and about four-fifths of a million were totally destroyed, nevertheless there is an increase for 1928–29 of nearly three and a half million new trees over the year before.

At the end of 1928–29 season there were 101,527,030 coconut trees planted in the Islands, of which 65,082,800 were bearing nuts and 374,770 were distilling tuba, representing an increase of 3 per cent in the number of coconut trees planted, of 6 per cent in the number of trees bearing and of 10 per cent in the number of tuba trees, as compared with the preceding year.

During the year the average yield of nuts per tree was 33, or 2 more than the year before, but the liters of tuba per tree decreased to 201 from 218 last year. Accordingly the total production of coconuts amounted to 2,155,530,000 for 1928–29 as the most ever gathered in the Islands as against 1,906,804,000 in 1927–28, while the corresponding production of tuba was 115,847,330 and 113,694,610 liters, respectively.

A little over one-tenth of the coconuts produced or, 235,411,000, were used in the desiccated coconut industry and for food purposes and the remainder were turned into copra and coconut oil. As most of the coconuts gathered are used for copra making, the production of copra of this year was also the largest ever registered, being 7,591,960 piculs of 63.25 kilos each or 11 per cent more than that for 1927–28, which was a record year. The production of coconut oil from the coconut, a home industry,

decreased from 1,933,580 liters in 1927–28 to 1,639,630 liters in 1928–29.

Municipal market prices were generally lower in 1928–29 than the year before, excepting those for tuba. The average price of copra was ₱8.89 per picul, that for 100 coconuts was ₱3.31, for coconut oil ₱0.37 per liter and for tuba ₱0.11 per liter. The corresponding prices for 1927–28 were ₱10, ₱3.85, ₱0.41 and ₱0.09, respectively. At these rates the aggregate value of all coconut products was ₱89,093,620 in 1928–29 as against ₱85,408,430 in 1927–28.

Table IV gives the area planted to coconuts, the number of trees growing, the production of nuts, copra, coconut oil, and tuba, the average prices and the total value of all coconut products for 1903 and from 1910 to 1928, inclusive.

TABLE IV

Years ending June 30—	Area cultivated in hectares	Number of trees planted			
		Total	Bearing	Tuba	Young
1903	148,240	(b)	(b)	(b)	(b)
1910	164,190	32,838,540	(b)	(b)	(b)
1911	208,480	41,695,160	24,128,890	209,170	17,357,100
1912	230,680	46,136,350	28,921,720	221,350	16,993,280
1913	223,210	44,642,410	24,424,550	234,140	19,983,720
1914	245,950	49,190,370	23,650,660	300,270	25,239,440
5-year average	214,500	42,900,570			
1915	264,150	52,829,680	28,860,530	285,400	23,683,750
1916	270,770	54,153,850	29,720,840	299,100	24,133,910
1917	301,220	60,244,050	30,965,470	242,640	29,035,940
1918	331,390	66,278,400	37,173,020	466,240	28,631,140
1919	368,600	73,720,100	41,997,410	557,310	31,255,380
5-year average	307,230	61,445,210	33,743,450	370,140	27,348,020
1920	397,030	79,406,100	43,585,410	630,860	35,189,830
1921	417,960	83,591,900	46,459,180	550,330	36,582,390
1922	444,570	84,536,710	49,379,910	609,860	34,546,940
1923	456,440	86,707,380	49,809,380	1,028,520	35,869,480
1924	460,440	87,460,000	51,154,600	540,460	35,764,940
5-year average	435,290	84,340,420	48,077,700	672,010	35,590,710
1925	472,050	89,637,770	53,165,880	449,210	36,022,680
1926	485,030	91,908,700	54,650,430	465,790	36,792,480
1927	500,010	94,877,740	58,414,390	513,680	35,949,670
1928	515,510	98,056,330	61,068,390	520,400	36,467,540
1929	513,040	101,527,030	65,082,800	574,770	35,869,460
5-year average	500,730	95,201,510	58,476,380	504,770	36,220,360

TABLE IV—Continued

Years ending June 30	Total nuts gathered	Nuts consumed fresh	Copra produced	Oil produced	Tuba produced
			Piculs	*Liters*	*Liters*
1903	232,314,800	(b)			
1910	937,927,930	311,609,150	1,867,840	6,993,510	174,483,480
1911	965,155,700	154,980,730	1,870,720	6,602,970	37,649,880
1912	1,041,181,900	96,262,490	2,751,550	4,868,100	39,842,910
1913	781,585,500	147,981,010	1,845,060	5,010,540	42,145,870
1914	591,266,400	63,057,700	1,697,750	3,595,330	54,048,390
5-year average	863,423,490	154,778,220	2,006,580	5,414,090	69,634,110
1915	865,815,830	72,441,160	2,712,630	3,175,630	51,372,210
1916	735,275,750	63,818,410	2,241,330	2,688,300	53,938,610
1917	880,588,810	64,586,490	2,948,790	2,623,690	43,674,590
1918	1,397,796,110	91,612,160	4,942,180	4,555,330	83,922,800
1919	1,344,950,600	75,358,580	4,944,160	5,142,210	100,315,520
5-year average	1,044,885,420	73,563,360	3,557,820	3,637,030	66,644,750
1920	1,509,504,290	84,216,090	5,717,080	2,879,450	98,068,840
1921	1,547,583,130	83,556,120	5,922,880	2,706,720	103,854,740
1922	1,467,684,000	68,239,000	5,799,350	2,872,230	105,431,050
1923	1,515,253,000	57,556,000	5,820,250	2,578,770	121,802,580
1924	1,576,629,000	45,588,000	6,119,150	1,865,770	114,581,800
5-year average	1,523,330,680	67,831,040	5,875 740	2,580,590	108,747,800
1925	1,584,519,000	110,678,000	5,726,800	1,993,450	87,252,200
1926	1,627,379,000	148,759,000	5,780,700	1,787,810	99,001,810
1927	1,800,027,000	160,276,000	6,484,750	1,973,710	107,772,910
1928	1,906,804,000	163,211,000	6,840,530	1,933,580	113,694,610
1929	2,155,530,000	235,411,000	7,591,960	1,639,630	115,847,330
5-year average	1,814,851,800	163,667,000	6,484,950	1,865,630	104,713,770

Years ending June 30	Average price				Grand total
	Per 100 nuts	Copra per picul	Oil per 100 liters	Tuba per 100 liters	
1910	₱2.07	₱6.55	₱20.71	₱3.45	₱26,161,630
1911	3.00	9.49	30.00	5.00	26,261,270
1912	3.00	10.75	30.00	5.00	35,926,540
1913	4.00	11.38	30.00	5.00	30,535,660
1914	4.00	10.23	34.08	6.51	24,651,760
5-year average	2.90	9.76	28.14	4.46	28,707,370
1915	2.90	6.77	20.86	6.47	24,461,880
1916	3.41	8.48	26.53	4.68	24,430,950
1917	3.73	9.00	31.32	4.99	31,975.490
1918	3.63	8.33	29.66	6.64	51,424,420
1919	4.39	10.91	36.00	10.00	69,204,960
5-year average	3.62	8.94	29.89	7.11	40,299,540
1920	6.70	18.78	59.00	14.00	128,196,890
1921	4.73	10.04	52.73	10.95	76,19[illegible].530
1922	2.99	7.60	37.87	7.67	55,267,680
1923	3.32	8.93	35.36	7.87	64,366,220
1924	3.57	9.39	40.67	7.22	68,134,370
5-year average	4.47	10.90	45.70	9.34	78,431,540
1925	3.46	10.47	42.72	8.26	71,847,980
1926	4.17	11.28	46.94	9.21	81,369,370
1927	3.84	9.95	44.37	9.69	81,985,970
1928	3.85	10.00	41.49	8.74	85,408,430
1929	3.51	8.89	37.19	10.96	89,093,620
5-year average	3.76	10.04	42.65	9.44	81,941,070

Sugar cane.—An enormous crop raised this year, the largest ever registered in the Islands.

During the year there were put into cultivation 257,710 hectares to sugar cane, an increase of 9 per cent over the area planted the year before, and this area yielded 13,395,700 piculs of 63.25 kilos each of sugar and *panochas.* This represents an increase of nearly 16 per cent over the figure of 1927–28, which was itself a record crop.

This extraordinary increase is the result of the increasing number of sugar centrals that are established in the Islands, for the largest increases were registered in those provinces where centrals are located, and especially so in the Province of Tarlac, where the biggest central in the world was erected this year. In this province alone, there was an increase of over half a million piculs over the yield of last year. Pampanga came next with an increase of nearly half a million piculs, Occidental Negros followed with an increase of nearly 400,000 piculs, and Laguna with a little over 200,000 piculs. Oriental Negros, Cebu, and Ilocos Sur recorded decreases instead, and particularly the first one named due to unfavorable weather.

As to the classification of the sugar produced, it is estimated that 11,035,410 piculs are centrifugal sugar, 1,744,620 piculs are muscovados, and 615,670 piculs are *panochas.*

There were also increases recorded in the production of *basi* and molasses. The total produce of *basi* was 6,135,900 liters and that of molasses, 20,459,490 liters, as against 5,440,250 and 11,203,010 liters respectively, the preceding year.

Almost all the sugar-producing provinces gave higher yields of sugar per hectare, with the two principal exceptions of Oriental Negros and Cebu, which sustained losses in the yields due to bad weather. The average yield per hectare for the entire Islands was 51.9 piculs in 1928–29, as against 48.9 piculs in 1927–28.

Prices for *basi* advanced from ₱0.15 a liter in 1927–28 to ₱0.22 in 1928–29, but fell for sugar to ₱8.74 per picul from ₱9.77 that was quoted the year before; those for *panochas* fell also to ₱7.91 per picul this year from ₱8 in 1927–28 and the molasses were sold this year at a reduction of 2 centavos, or ₱0.09 per liter as compared with the previous year.

The aggregate value of all sugar-cane products was ₱119,915,120 and that for the preceding year ₱114,136,710.

The following table gives the total area planted, the production of sugar, *panocha*, *basi*, and molasses, the average yield of sugar and *panochas* combined, the average prices and the total value of the whole crops since 1910.

TABLE V

Years ending June 30—	Area cultivated	Sugar Production: All sugars	Sugar Production: *Panochas*	Sugar Production: Total	*Basi*	Molasses
	Hectares	*Piculs*	*Piculs*	*Piculs*	*Liters*	*Liters*
1903 [b]	71,880	[c]	[c]	2,849,290	[d]	[d]
1910	83,170	[c]	[c]	2,413,260	[d]	[d]
1911	120,310	[c]	[c]	3,856,510	[d]	[d]
1912	164,250	3,831,380	204,080	4,035,460	11,856,830	3,858,280
1913	176,120	4,606,910	342,520	4,949,430	8,987,650	2,301,450
1914	169,440	5,477,150	379,650	5,856,800	9,342,519	2,480,030
5-year average	142,660	....	....	4,222,290	....	....
1915	173,090	5,694,490	346,660	6,041,150	5,544,150	2,339,090
1916	179,760	5,538,060	375,190	5,913,240	6,763,320	2,216,640
1917	185,930	5,728,670	370,920	6,099,590	7,016,840	1,969,500
1918	205,510	6,264,710	544,550	6,809,260	7,106,780	5,085,990
1919	200,200	5,994,100	508,230	6,502,330	8,716,980	2,038,710
5-year average	188,900	5,844,000	429,110	6,273,110	7,027,610	2,729,990
1920	197,400	6,195,460	501,460	6,696,920	10,069,810	4,095,980
1921	241,340	8,065,950	388,340	8,454,290	8,039,590	7,524,740
1922	240,820	7,200,070	447,450	7,647,520	10,537,980	8,920,890
1923	227,290	6,446 800	370,780	6,817,580	7,531,230	9,876,230
1924	227,190	7,132,640	456,100	7,588,740	3,880,570	2,976,550
5-year average	226,810	7,008,180	432,830	7,441,010	8,011,840	6,678,880
1925	239,470	10,659,480	521,030	11,180,510	4,315,210	4,833,860
1926	231,840	8,195,370	516,020	8,711,390	4,298,790	5,935,540
1927	237,350	10,434,910	564,750	10,999,660	4,066,020	4,365,550
1928	237,000	10,951,940	634,530	11,586,470	5,440,250	11,203,010
1929	257,710	12,780,030	615,670	13,395,700	6,135,900	20,459,490
5-year average	240,670	10,604,350	570,400	11,174,750	4,851,230	9,359,490

[b] Census 1903. [c] Not classified by products to 1912. [d] Not available.

TABLE V—Continued

Years ending June 30—	Average production per hectare[a]	Average price				Total value
		Sugar	*Panochas*	*Basi*	Molasses	
	Piculs	*Piculs*	*Piculs*	*100 liters*	*100 liters*	
1903	39.48	([b])	([b])	([b])	([b])	([b])
1910	29.02	([b])	([b])	([b])	([b])	₱15,263,930
1911	32.05	([b])	([b])	([b])	([b])	24,392,460
1912	24.57	₱6.32	₱6.32	₱6.00	₱5.00	26,428,630
1913	28.10	5.06	5.06	6.00	5.00	25,698,450
1914	34.56	4.76	4.55	7.31	7.52	28,631,540
5-year average	29.60	....	....	....	....	24,083,000
1915	34.90	5.41	5.13	7.81	8.74	33,212,490
1916	32.89	5.65	5.79	7.41	8.02	34,136,130
1917	32.81	6.20	6.51	8.59	8.23	38,704,710
1918	33.13	5.79	6.95	7.59	11.69	41,158,780
1919	32.48	11.41	9.44	12.03	10.99	74,462,820
5-year average	33.21	6.92	6.97	8.89	9.98	44,334,990
1920	33.93	23.66	18.95	24.00	18.34	159,257,120
1921	35.03	11.01	11.96	20.97	15.98	96,378,980
1922	31.76	7.21	6.84	18.53	8.72	57,903,040
1923	29.99	12.74	8.00	19.65	12.60	87,831,550
1924	33.40	14.06	9.50	16.78	13.17	105,667,180
5-year average	32.81	13.41	11.32	20.43	13.08	101,407,570
1925	46.69	10.06	8.39	16.49	9.11	112,729,900
1926	37.57	8.89	8.32	15.36	9.15	78,401,990
1927	46.30	10.38	7.65	13.71	10.03	113,591,090
1928	48.89	9.77	8.00	15.24	10.85	114,136,710
1929	51.98	8.74	7.95	21.72	9.49	119,915,120
5-year average	46.43	9.56	8.05	16.69	9.78	107,754,960

[a] Including sugar and *panochas*. [b] Not available.

Abacá.—This premier fiber registered this year a record crop, partly because of the ever increasing activity of the Davao planters and partly because of the need of money felt by the planters in those provinces where the typhoon of November, 1928 caused serious damage both to the plantations and homes of the farmers.

Until not long ago, Davao Province occupied sixth place as to the provinces leading in the area cultivated to abacá and it ranked third in the order of production. This year, however, it advanced to 4th place in area planted and now leads all the provinces in production. The production of abacá for 1928–29 was a little over a half million piculs more than for 1927–28 and more than half of this increase came from the Province of Davao alone. The area planted in this province during the year reviewed was 58,160 hectares and the yield 743,410 piculs, or about $\frac{1}{8}$ of the total area planted to abacá in the Islands and over $\frac{1}{5}$ of its total yield.

The crisis that was felt immediately after the typhoon because of the destruction of the homes and plantations of many farmers,

and the stripping of the fallen stalks contributed also to increase the production of abacá of this year.

At the end of the year there were planted to this fiber 484,850 hectares, of which 403,130 were productive and yielded 3,373,810 piculs of 63.25 kilos each, of abacá. The corresponding figures for the year before were 480,730 hectares, 394,910 hectares and 2,826,340 piculs.

Due to this extraordinary production and the planters' need of money in the regions hit by the typhoon, the prices of abacá were considerably lower than those for 1927–28, the averages being ₱16.24 and ₱19.23 per picul respectively.

The total crop for 1928–29 was valued at ₱54,814,360 as against ₱54,362,440 the year before.

The following table shows from 1910 to 1929, the total area planted to abacá, the area productive, the total production, the average yield per hectare, the average price per picul and the total value.

TABLE VI

Years ending June 30—	Area: Planted	Area: Productive	Production	Average per hectare	Average price per picul	Total value
	Hectares	*Hectares*	*Piculs*	*Piculs*		
1903[a]	217,810	....	1,055,430	....	(b)	(b)
1910	475,140	(b)	2,663,270	....	₱10.12	₱26,952,340
1911	404,160	(b)	2,717,460	....	10.12	27,500,740
1912	432,800	(b)	2,521,320	....	11.38	28,705,210
1913	368,210	(b)	2,221,660	....	14.45	32,319,680
1914	437,470	(b)	2,176,060	....	13.77	29,968,010
5-year average	423,560	....	2,459,950	....	11.83	29,089,200
1915	457,860	331,130	2,437,820	7.36	12.48	30,420,740
1916	448,660	331,880	2,415,120	7.27	17.71	42,767,340
1917	488,500	341,760	2,544,720	7.45	24.99	63,598,140
1918	512,510	344,060	2,638,160	7.67	35.06	92,493,220
1919	515,560	340,640	2,345,310	6.88	27.72	65,006,010
5-year average	484,620	337,890	2,476,230	7.33	23.77	58,857,090
1920	559,360	361,830	2,609,980	7.21	24.16	63,058,850
1921	548,090	281,440	1,713,100	6.09	15.66	26,829,220
1922	494,990	264,500	1,913,770	7.24	10.41	19,918,860
1923	513,420	375,620	2,986,380	8.67	13.16	39,317,490
1924	485,340	374,180	3,125,450	8.35	13.82	43,186,250
5-year average	520,240	331,510	2,469,740	7.45	15.57	38,462,130
1925	477,110	382,860	2,853,570	7.45	22.53	64,296,240
1926	492,050	387,240	2,878,060	7.43	22.84	65,724,830
1927	480,150	381,490	2,731,630	7.16	21.69	59,240,800
1928	480,730	394,910	2,826,340	7.16	19.23	54,362,440
1929	484,850	403,130	3,373,810	8.37	16.24	54,814,360
5-year average	482,980	389,930	2,932,680	7.52	20.35	59,687,730

[a] Census 1903. [b] Not available.

Corn.—Weather conditions were unfavorable for the growing of this crop during the year, so that the production suffered a

reduction of 16 per cent as compared with that for last year and also of 1 per cent in the area planted.

There were 515,040 hectares planted to this grain, which yielded an average of 11.92 cavans of 58.5 kilos each, of shelled corn per hectare, or a total crop of 6,141,690 cavans.

The year before the area under cultivation was 519,680 hectares yielding 7,342,300 cavans, at the rate of 14.13 cavans per hectare.

Due to this shortage, there was an advance in the prices of corn in the municipal markets of about 43 centavos per cavan over the average price of last year, which was the lowest average price paid since 1918.

The total crop for 1928–29 was sold for ₱24,431,600 as against ₱26,104,700, the price at which the crop for 1927–28 was disposed.

Table VII, gives the area planted to corn, production, average yield per hectare, average price per cavan and the total value of the crop since 1910.

TABLE VII

Years ending June 30—	Area cultivated	Amount of shelled corn produced	Average production per hectare	Average price of shelled corn per cavan	Total value
	Hectares	*Cavanes* [c]	*Cavanes*		
1903	107,980	1,593,670	14.76	(a)	(a)
1910 [b]	288,270	2,467,570	8.56	₱3.51	₱8,661,180
1911	302,520	2,485,400	8.22	3.51	8,723,740
1912	340,200	3,666,200	10.78	3.51	12,868,360
1913	383,710	4,339,340	11.31	3.51	15,231,080
1914	421,510	6,266,150	14.87	2.53	15,873,800
5-year average	347,240	3,844,930	11.07	3.19	12,271,630
1915	443,050	6,908,360	15.69	2.33	16,067,660
1916	432,770	6,616,940	15.29	2.23	14,723,960
1917	428,290	6,315,450	14.75	2.79	17,639,800
1918	418,390	5,295,700	12.66	3.97	21,018,650
1918 [d]	364,010	10,266,580	28.20	(a)	(a)
1919	430,710	5,686,090	13.20	6.53	37,116,430
5-year average	430,640	6,164,510	14.31	3.46	21,313,300
1920	537,130	7,372,100	13.72	6.91	50,910,870
1921	543,830	6,884,000	12.66	5.55	38,187,270
1922	549,960	6,416,450	11.67	4.54	29,125,200
1923	557,690	7,528,920	14.04	4.10	32,388,700
1924	533,230	7,830,320	14.00	4.20	33,303,960
5-year average	544.370	7,266,360	13.35	5.06	36,783,200
1925	522,380	7,606,110	14.56	4.00	30,767,250
1926	533,570	7,899,730	14.80	4.70	37,370,300
1927	561,430	8,384,710	14.93	4.14	34,697,470
1928	519,680	7,342,300	14.13	3.55	26,104,700
1929	515,040	6,141,690	11.92	3.98	24,431,600
5-year average	530,420	7,474,910	14.09	4.10	30,674,260

[a] Not available. [b] Census data. [c] One cavan of corn = 58 kilos excluding weight of sack.

Tobacco.—The handicaps encountered during the year by the tobacco planters were greater than those faced the previous year as regards weather and financial conditions. However, the generous rain that fell during the growing period and the better care taken of the plantations, combined to enable the raising of the same yield per hectare as the year before but of a superior quality.

The total area planted during the year was 82,620 hectares, or 3 per cent more than for 1927–28 season and the yield was also 3 per cent greater or 1,030,840 quintals of 46 kilos each, of tobacco leaf. The average yield per hectare for both years was the same—12.47 quintals.

The prices offered during the year advanced somewhat over those for 1927–28; nevertheless they were lower than those paid since 1924. The price for 1928–29 was ₱10.15 per quintal as against ₱9.30 in 1927–28.

At these rates the crops for 1928–29 and 1927–28 were valued at ₱10,463,050 and ₱9,334,770, respectively.

The following table gives the details for this crop since 1910.

TABLE VIII

Years ending June 30	Area planted	Production	Average per hectare	Average price per quintal	Total value
	Hectares	*Quintals*	*Quintals*		
1903	31.420	369.770	11.77	(b)	(b)
1910	53,630	608,840	11.35	₱6.90	₱4,201,020
1911	69,020	554,740	8.04	6.90	3,827,720
1912	57,040	643,110	11.27	6.90	4,437,470
1913	68,990	1,001,310	14.51	6.90	6,909,060
1914	60,890	1,015,900	16.68	7.00	7,109,370
5-year average	61,910	764,780	12.35	6.93	5,296,930
1915	53,340	832,670	15.61	6.83	5,684,580
1916	58,910	894,330	15.18	8.12	7,259,170
1917	61,780	1,063,670	17.28	10.23	10,882,520
1918	78,440	1,338,160	17.06	11.37	15,219,150
1919	73,860	1,228,210	16.63	14.32	17,585,450
5-year average	65,270	1,071,410	16.41	10.57	11,326,370
1920	101,120	1,410,730	13.95	18.97	26,765,950
1921	90,980	1,147,800	12.62	7.65	8,777,570
1922	59,870	650,580	10.87	9.25	6,019,370
1923	64,730	713,170	11.02	9.55	6,814,800
1924	72,090	941,800	13.06	12.22	11,505,420
5-year average	77,760	972,820	12.51	12.31	11,976,720
1925	71,630	910,910	12.72	13.05	11,891,590
1926	74,790	988,010	13.21	12.09	11,943,460
1927	83,970	1,091,660	13.00	12.07	13,180,840
1928	80,480	1,003,840	12.47	9.30	9,334,770
1929	82,620	1,030,840	12.48	10.15	10,463,050
5-year average	78,700	1,005,050	12.77	11.30	11,362,740

[b] Not available.

Maguey.—At the close of the year 1928–29 there were 37,260 hectares planted to this fiber as against 35,630 hectares the preceding year, or an increase of 5 per cent.

Nearly four-fifths of the area planted this year was in production and yielded 336,470 piculs of 63.25 kilos each, of maguey, while the year before it was 308,580 piculs, or an increase of 9 per cent.

This crop, that for 1928–29, was sold in the municipal markets at ₱3,538,030, at the rate of ₱10.52 per picul, as against ₱3,288,130, the value of the preceding crop.

The following table shows the area planted, production, value, etc. of maguey since 1912.

TABLE IX

Years ending June 30—	Area cultivated	Area productive	Amount of maguey (cantala) produced	Average production per hectare	Average price per picul	Total value
	Hectares	*Hectares*	*Piculs*	*Piculs*		
1912	8,598	8,600	73,175	8.51	₱7.59	₱555,399
1913	9,283	9,280	57,233	6.17	8.22	470,596
1914	18,218	10,300	119,902	11.65	7.18	860,854
3-year average	12,033	9,393	83,437	8.77	7.54	628,916
1915	19,218	12,420	99,851	8.05	6.24	622,587
1916	30,804	23,570	211,695	8.98	8.25	1,747,263
1917	28,099	22,080	271,778	12.31	12.38	3,363,381
1918	32,601	21,970	263,474	11.99	14.07	3,707,213
1919	28,465	17,970	194,757	10.83	9.86	1,919,750
5-year average	27,837	19,600	208,311	10.62	10.91	2,272,039
1920	30,567	20,280	287,400	14.17	11.86	3,407,959
1921	30,385	16,520	145,098	8.78	7.27	1,054,261
1922	27,670	19,170	268,700	14.02	6.31	1,694,470
1923	28,575	24,880	427,400	19.25	7.06	3,018,770
1924	29,380	25,620	443,010	17.00	8.24	3,649,140
5-year average	29,315	21,290	317,921	14.64	8.15	2,564,920
1925	31,100	24,900	456,000	18.31	12.46	5,682,530
1926	33,350	25,250	400,400	15.86	12.58	5,036,250
1927	34,000	25,080	315,470	12.58	12.17	3,838,490
1928	35,630	26,720	308,580	11.55	10.66	3,288,130
1929	37,260	29,430	336,470	11.43	10.52	3,538,030
5-year average	34,270	26,280	363,380	13.83	11.77	4,276,690

Cacao and coffee.—The increasing consumption in the Islands of these aromatic plants and the considerable importations that the country is making of them to make up for the shortage in their production is encouraging the planting of more and more cacao and coffee every year.

At the end of the year there were 2,321,000 cacao trees and 2,993,700 coffee trees planted in the Islands as against 2,156,800 and 2,842,700 trees that were under cultivation the year before.

As only about half of the trees planted are bearing the production of cacao was only 1,215,800 kilos and that of coffee was

1,301,400 kilos. The respective yields for the year 1927–28 were 1,172,900 and 1,236,600 kilos.

The crops were disposed of for ₱1,239,200 for cacao and for ₱926,300 for coffee, as against ₱1,183,700 and ₱868,600, respectively.

In the following tables the details for both products are given since 1914.

TABLE X

Years ending June 30—	Trees cultivated	Trees bearing	Area cultivated	Production	Average price per kilo	Total value
	Numbers	*Numbers*	*Hectares*	*Kilos*		
1903 [a]	(b)	(b)	3,521	482,470	(b)	(b)
1914	1,864,900	1,004,600	1,305	565,800	₱0.62	₱354,060
1915	1,869,700	1,046,400	1,309	625,610	.64	399,000
1916	1,719,500	1,029,600	1,204	558,360	.62	345,060
1917	1,618,000	919,600	1,133	537,330	.63	338,500
1918	1,827,900	998,600	1,279	566,200	.89	504,670
1919	1,853,200	1,009,400	1,297	572,740	.93	535,050
5-year average	1,777,700	1,000,700	1,244	572,050	.74	424,460
1920	1,872,700	725,700	1,310	923,500	1.12	924,700
1921	1,656,200	934,900	1,159	888,940	1.43	1,267,700
1922	1,912,700	1,067,500	1,339	1,078,200	1.15	1,244,400
1923	1,925,400	1,086,000	1,348	1,045,400	1.09	1,145,500
1924	1,969,400	1,074,700	1,378	1,160,800	1.04	6,206,600
5-year average	1,867,100	977,800	1,307	999,370	1.16	1,157,780
1925	2,000,300	1,125,800	1,400	1,111,900	1.07	1,189,100
1926	2,029,400	1,171,900	1,420	1,082,700	1.03	1,119,400
1927	2,042,500	1,179,400	1,430	1,089,100	1.03	1,127,600
1928	2,156,800	1,244,000	1,510	1,172,900	1.01	1,183,700
1929	2,321,000	1,290,900	1,625	1,215,800	1.02	1,239,200
5-year average	2,110,000	1,202,400	1,477	1,134,480	1.03	1,171,800
			COFFEE			
1903 [a]	(b)	(b)	999	90,540	(b)	(b)
1914	1,970,000	1,130,000	788	626,410	₱0.48	₱302,770
1915	2,098,200	1,174,600	839	694,860	.49	342,150
1918	2,111,000	1,352,900	844	752,200	.48	361,750
1917	1,650,300	1,022,500	660	594,680	.47	281,590
1918	1,920,600	1,208,700	768	721,850	.62	445,980
1919	1,931,600	1,209,700	773	717,230	.72	514,340
5-year average	1,948,300	1,193,700	777	696,150	.56	389,160
1920	2,015,200	1,130,200	806	998,800	.82	823,800
1921	2,096,500	1,064,400	839	1,062,300	.99	1,054 380
1922	2,205,300	1,164,500	882	1,148,900	.72	822,800
1923	2,184,500	1,179,800	874	1,155,700	.68	787,300
1924	2,259,400	1,193,700	904	1,173,600	.69	806,900
5-year average	2,152,200	1,146,500	861	1,107,900	.77	859,040
1925	2,335,600	1,295,900	934	1,178,200	.71	836,300
1926	2,515,600	1,455,900	1,006	1,207,300	.69	836,700
1927	2,533,700	1,461,000	1,013	1,209,800	.69	840,800
1928	2,842,700	1,522,000	1,137	1,236,600	.70	868,600
1929	2,993,700	1,582,500	1,197	1,301,400	.71	926,300
5-year average	2,644,260	1,461,460	1,035	1,226,600	.70	861,740

[a] No figures available from 1904 to 1913.

[b] Not available.

Livestock.—It is impossible in the short period elapsing between the end of the year and the date fixed for presenting this report, to complete the compilation of the data for the year 1929. For this reason the figures for animals given in this report are, as usual, one year late, that is, they are for December 31, 1928.

Large animals.—Conditions as to animals during the year 1928 were generally very good.

There were registered increases in the number of carabaos, horses, and cattle and greater for the first two kinds but smaller for the last as compared with the increases recorded in the preceding year 1927.

These increases were 3.68 per cent for carabaos, 6.29 per cent for horses, and 4.08 per cent for cattle as against 3.47, 2.74, and 4.73 per cent, respectively.

The rates of births were maintained in fractions of one per cent higher for all these animals and the rates of mortality were smaller by fractions of one per cent over those of the preceding year. The rates of births were 14.49 per cent for carabaos, 15.63 per cent for horses, and 18.57 per cent for cattle as against 14.33, 14.71, and 18.19 per cent, respectively for 1927. The rates of mortality were 1.35 per cent for carabaos, 2.52 for horses, and 2.08 for cattle as against 1.35, 2.97, and 1.82 per cent, respectively for 1927.

There were in 1928 increases in the consumption of meat of carabaos and horses, but decreases of one and a half per cent in the consumption of beef, as compared with 1927. The number of head slaughtered in the Islands during 1928 was 53,485 carabaos, 5,909 horses, and 134,538 cattle. The corresponding figures for 1927 were 50,880, 4,193, and 136,389.

The consumption of fresh beef in the City of Manila decreased also in 1928 as compared with 1927, but native beef was consumed in greater proportion than foreign, as compared with 1927.

During the year 1928 there were slaughtered 22,566 head giving 3,362,314.5 kilos of beef of which amount native cattle contributed with 14,507 head representing 1,763,946.5 kilos and the remainder was from Australia. In 1927, the consumption of beef amounted to 3,412,497.5 kilos from 22,874 head of which 12,633 head were native giving 1,408,912.5 kilos; 7,901 head were Australian giving 1,666,411 kilos and 2,340 head were Indo-Chinese giving 337,174 kilos.

The average weight of the native cattle slaughtered in 1928 was 122 kilos per head, or 10 kilos more than the average weight recorded in 1927.

The heavy native cattle slaughtered in the City of Manila came from Agusan (162 kilos per head), Batangas (159 kilos), Bukidnon (156 kilos), Laguna (148 kilos), and Ilocos Sur (140 kilos). The remainder fluctuated between 52 and 129 kilos.

Of the number slaughtered, 24 per cent came from Batangas; 24 per cent from Masbate; 8 per cent from Zamboanga; 7 per cent from Ilocos Sur; 6 per cent from Mindoro; and 5 per cent from Bukidnon. The remainder came from different provinces of the Islands.

There were 606 carabaos also slaughtered in the City of Manila which gave 100,892 kilos of meat as against 133 head and 20,978 kilos in 1927.

It is interesting to note that 17.3 per cent of the native cattle slaughtered in the City of Manila in 1928 were females and of these 7.7 per cent were found with foetus.

Minor animals.—The number of hogs, goats, and sheep in the Islands for the year ending December 31, 1928, was considerably smaller than that reported for the year before.

This seeming decrease is chiefly due to the fact that more accurate information was obtained from municipal officials as to the number of minor animals in the Islands. Prior to the year 1928 the figures obtained for minor animals were rough estimates prepared by municipal officials, inasmuch as no annual census thereof was ever taken. As a consequence of this, and misled by the general belief as to the prolific qualities of these animals, they overestimated the rates of births and there was on the other hand no way of checking their biased information as this Office has no personnel for this work. Only an annual census would remedy this defect.

The taking of an annual census is a very serious matter, for not only does it involve a huge quantity of work and consequently great expense but is liable also to contain many errors because the municipal officials lack facilities to get accurate data. However, strenuous efforts were made during the year 1928 to take a census of these animals and for the first time an annual census was taken for the year ending December 31, 1926.

The returns of this annual census were not as complete as desired, nevertheless they were near enough so to disclose the general tendency in the past of the municipal presidents of overestimating the rates of increases. A new annual census of minor animals was taken for the year ending December 31, 1929, and it is expected that upon the termination of the compilation of the returns of this second annual census a better idea of facts and figures will be gained and a general correction of the figures for past years will be made and published.

ADMINISTRATIVE DIVISION

At the beginning of the year there were 550 employees on the roll of the Bureau. One hundred fifty-eight employees were appointed and 97 separated from the service, leaving 611 employees on December 31, 1929, or 61 more than the preceding fiscal year. This was due to the increased activities of the Bureau, especially in the campaigns for the control of animal and plant pests and diseases.

Correspondence.—The following table shows the correspondence attended and the amounts spent therefor in 1928 and 1929:

Year	Letters		Total	Postage	Telegrams
	Received	Sent			
1929	169,269	132,897	302,166	₱8,104.14	₱855.39
1928	160,495	154,410	314,905	7,961,28	798.74
Increase (+) or decrease (—)	+8,774	·21,513	12,739	+142.86	+56.65

ACCOUNTING DIVISION

The payment of the accounts, especially the salaries of the field employees, the reimbursement of their traveling expenses, and the reimbursement of the disbursement of our special disbursing officers were always attended to with dispatch and the corresponding warrants sent to them with the least possible delay. Very frequently warrants for the field employees had to be rushed.

Despite the increase of work the accounts were kept up to date, the monthly statements for the Bureau of Audits were submitted within the period prescribed by the rules and regulations, and the monthly statements of expenditures and incomes prepared for the Directors and the division chiefs submitted on time.

While closing the books and accounts of the Bureau of Agriculture, the division is at the same time opening the accounts of both the new two Bureaus, Plant Industry and Animal Industry.

PROPERTY DIVISION

Only two buildings were constructed; namely, the Serum Laboratory, started last year in Pandacan, Manila, and the new Plant Quarantine Office at the Port Area. Alterations and repairs were also made in the office at the Alabang Stock Farm and the Office Laboratory at La Carlota Sugar Experiment Station.

Six Arabian stallions were imported December 31, 1929, from India. Besides these, laboratory instruments and apparatuses and agricultural implements were acquired.

One truck was added to the two "White" trucks, to handle the shipment of our materials. The trucks traveled over 50,000 kilometers and handled more shipments and deliveries in 1929 than in the previous years.

WORK DONE DURING THE YEAR

	1929	1928	Increase (+) or Decrease (—)
Requisitions for equipment and supplies (Bureaus of Supply and Printing)	479	707	228
Direct orders (contract payments)	224	222	+ 2
Work and repair orders	268	226	+ 42
Requests for equipment and supplies	3,671	5,749	2,078
Issue vouchers	7,500	6,500	+ 1,000
Memorandum and invoice receipts	805	856	- 51
Report of supplies issued	58	55	+ 3
Bills checked, verified, audited and journalized	720	600	+ 120
Descriptive lists prepared	1,418	250	+1,168
Death certificates, autopsy reports and affidavits cleared	1,527	800	+ 727

FIXED ASSETS OF THE BUREAU

Classification	1929	1928	Increase (+) Decrease (—)
1. Land, buildings, irrigation systems, docks and wharves, telephone lines and other permanent improvements	₱835,817.75	₱839,468.83	—(₱3,651 08)
2. Watercraft, motor vehicles and other land transportation equipment including draft and work animals	103,211.59	106,028.03	2,816.44
3. Agricultural machinery and implements, scientific instruments and apparatuses, office and other miscellaneous equipment including experimental animals	366 227.	351,846.28	14,381.33
4. Aircraft and appurtenances	11 530.	11.530.86	
5. Breeding animals	55 987.	66.256.61	,269.54
6. Supplies charged to appropriation (B-15)	7.961.	9.829.44	,867.71
7. Sales stock (seeds, plants, etc.)	704.	2.126.80	,422.69
Grand total	1,381,440.72	1,387,086.85	— 5,646.13

DIVISION OF PLANT INVESTIGATIONS

ADMINISTRATION

Organization.—The name of the division was changed from "Plant Industry Division" to "Division of Plant Investigations" as per Act No. 3459 known as the Appropriation Law for 1929.

AGRONOMY PROJECTS

LOWLAND RICE

Alabang Rice Experiment Station, Alabang, Rizal

Acclimatization test.—Of 161 varieties of rice tested in 1928–29, the Arabon was the highest yielder.

Under the dry-season acclimatization test of 13 native varieties and two foreign grown, only the Kinawayan and the Pinirincesa yielded satisfactorily.

Variety test of palagad rice.—The Sipot and Guinangang (Strain 1) gave the highest yields of 55 and 51.9 cavans per hectare, respectively.

Multiplication tests.—The three-year tests (1926–1928) of 8 varieties of rice for multiplication the Ramai yielded an average of 70.5 cavans. These results were obtained from poor soil, lacking in organic matter.

In the 1929 test made with 16 varieties, three varieties have been harvested and the rest are still in the field. The harvested varieties are of early maturity; namely, the Guinangang Strain 1 with 43.0 cavans; Lubang Luay, 36; Minalabon (yet undetermined); and Apostol, 38.

Yield test of seedlings raised by "dapog" and ordinary seedbed methods.—In this trial the yield of seedlings using Sipot variety raised by the "Dapog" method was found to be 29.3 cavans, and that of ordinary "tubigan" 33.4 cavans per hectare.

Effect of noding in rice upon the yield.—Unnoded seedlings have increased over the seedlings with nodes buried in the soil, 51.8 per cent in grain yield and 91.0 per cent over the seedlings with nodes exposed. Noded seedlings buried deep likewise gained over the ones planted shallow by 25.9 per cent.

Pedigree work.—Of the two varieties under pedigree selection the Macan Culi-culi has already been harvested and the Elon-elon had just flowered. From the study of Macan Culi-culi rice it appears that Strain 14 and Strain 19 are the most productive of the 20 original elites. Their yields from 3-rowed plots of 100 plants to the row, were 2.85 kilos and 2.56 kilos,

respectively, as compared with the average check yield of 2.05 kilos. Field observations of the Elon-elon indicate that Strain No. 2, 5, or 7 may be the best.

Phosphate fertilizer experiment.—Although the results of the present work appear to have been influenced by lodging, yet the increase in yield following a moderate application of a certain phosphate fertilizer containing 25–30 per cent phosphoric acid-soluble in ammoniacal citrate, and 35–40 per cent active lime is probably certain. This increase was 11.6 cavans obtained with 133 kilos of the fertilizer over the average control yield of 57 cavans per hectare. The same amount of phosphate fertilizer with 180 kilos of sulphate of ammonia gave an even yield with the control, and 200 kilos of the phosphate fertilizer both applied singly and combined with sulphate of ammonia produced less yield.

Fertilizing value of "lia" (fresh water algae).—The material used in the experiment had been dried and reduced in size by pounding. It was applied at the rate of 60 kilos of nitrogen to the hectare. A gain of 3.6, 4.59, and 10.8 cavans over the control have been registered from these separate tests.

Rice breeding.—The F_1 hybrids of Inadhica x Ramai and reciprocals are the most promising hybrids among those produced in 1928.

Of the 27 new crosses the Elon-elon x Ramai, Inadhica x Khao Bai Sri, Ramai x Khao Bai Sri, Manticanon x Khao Bai Sri and Inadhica x Elon-elon have been attempted and hybrid seeds of some of them secured.

A study of natural crosses in rice.—Two varieties, the Elon-elon and Macan Biñan, with various contrasting physical characters of the grain and panicle, were used in this experiment. The rows were set across the directions of the prevailing winds and each variety was planted in alternate plots of 3 rows each, single plants to the hills at 20 centimeters apart each way. The plot located in the middle of the series was planted to seedlings of the two varieties, mixed in the hills. With the exception of the middle plot, the different rows will be harvested separately, and next year they will be raised for detection of natural hybrids. Both varieties had started to flower on December 9, 1929.

Isolation work was done in the field of Apostol, which revealed that little genetic mixture had taken place. The hybrid plants show certain characters of Cruz, another early variety. One plant was found to be a distinct type of an Apostol hybrid.

Rosales Rice Experiment Station, Rosales, Pangasinan

Acclimatization test.—The following were the results from the foreign rice varieties tested: Tjereh Soelandajama, 91 cavans per hectare; Lava (*a*), 87; Pahit Strain 7, 70; Tur Dung Bap, 65; Delitus, 60; Ngasein, 59; Tadung, 58; Radin 7, 58; Rading Kuning Strain 6, 57; Bhuang Ngem, 56; Seraup Strain 6–A, 55; Radin Kuning Strain 17–A, 55; Radin 2, 54; Radin Kuning Strain 13, 41; Tjereh Limar, 40; Siamese A, 37; and Vato, 37. Khao Bai Sri used as check produced 54 cavans per hectare.

Late-planting test.—Twelve early maturing rice varieties under test gave the following yields: Binicol, 66.0 cavans per hectare; Roxas, 62.5; Gallano (bearded), 60.0; Pinursigue, 58.0; Madaling araw, 54.0; Apostol, 51.5; Macaraniag (bearded), 50.0; Milagrosa, 40.0; Sipot, 36.0; Guinangang, 36.0; and Calibo II, 35.0. They were all broadcasted on August 24 and harvested in December.

Variety tests.—The maturity and yield per hectare of the different upland rice varieties tested this year were as follows: Lampadan, 120 days and 56.8 cavans; Saigorot, 124 days, 57.2 cavans; Capat-bulan, 98 days, 56 cavans; Salumanay, 120 days, 57.2 cavans; Penile-a-biit, 128 days, 60 cavans; Ban-nateran, 125 days, 55.4 cavans; Gabao, 101 days, 28.3 cavans; Balicayo, 121 days, 56.8 cavans; Saranay, 131 days, 45.4 cavans; Rabon, 106 days, 59.0 cavans; Curitay, 102 days, 40.0 cavans; Sarino, 102 days, 27.2 cavans; Tui, 108 days, 47.0 cavans; Kinitoman, 102 days, 42.0 cavans; Inantipolo, 124 days, 32 cavans; Madaling-araw, 106 days, 50 cavans; Mangasa, 111 days, 32 cavans; and Binicol, 124 days, 40 cavans.

Cultural experiments.—In the distance of planting test using Binacroy (lowland rice) in 5 replicated plots of 50 square meters each, planting 3 seedlings to the hill, the following average yields were obtained; 20 x 20 centimeters produced 70.5 cavans; 25 x 25 centimeters, 76 cavans; and 30 x 30 centimeters, 70 cavans per hectare.

Crop rotation experiments.—Mongo, native beans, and cowpeas were planted during the early part of February and the peanuts and *Tephrosia candida* during March. The mongo produced 7.6 tons of green manure and 7.5 cavans of seed per hectare; the cowpeas 19.1 tons of green manure; the native beans 9.4 tons of green manure; the peanuts 20 tons of green manure; and the *Tephrosia candida* had poor germination and did not produce a normal crop. Apostol rice was used in this test, which gave the following average yields: Control plot No. 1,

40 cavans of palay per hectare; mongo plot, 58.5; native bean plot, 63; peanut plot, 68.5; *Tephrosia candida* plot, 60.6; and control plot II (followed during the dry season), 57 cavans.

Fertilizer tests.—In the experiment on the fertilizer requirements of lowland rice using Apostol variety the plot containing 50 per cent nitrogen, 25 per cent phosphoric acid and 25 per cent potash gave the best results, with 92.2 cavans or 15.7 cavans over the average production of 76.5 cavans of the control plots to the hectare.

The application of 300 kilos of ammonium sulphate per hectare produced an average of 66.1 cavans and Brand No. 11 with the application of 300 kilos per hectare produced 65.9 cavans. The Brand No. 18 fertilizer did not have a distinct effect upon the Sipot but heavy applications of lime produced an average yield per hectare of 41.8 cavans.

In a fertilizer test with ammonium sulphate on Apostol palay the following results were obtained: the average of 5 check plots used was 65.2 cavans; at 100 kilos per hectare, 71.1 cavans; at 200 kilos, 79.9 cavans; at 300 kilos, 83.2 cavans of palay per hectare.

In another fertilizer test of a certain brand of fertilizer (Brand No. 9), containing 9 per cent N, 9 per cent P_2O_5, and 4 per cent K_2O with Khao Bai Sri lowland rice the following results were obtained; average of 4 check plots, 34.5 cavans; at 100 kilos per hectare, 39.9 cavans; at 200 kilos, 39.2 cavans; and 300 kilos, 41.2 cavans per hectare.

Brand No. 8, a fertilizer containing 5 per cent N, 8 per cent P_2O_5, and 10 per cent K_2O, gave the following results on Khao Bai Sri this year: average of 4 check plots, 32.6 cavans; the application of 100 kilos of the fertilizer produced 36.9 cavans; at 200 kilos, 39.1 cavans; and at 300 kilos, 43.3 cavans per hectare.

Coöperative trial planting work.—In a coöperative experiment in Tayug, Pangasinan, the variety Ramai produced 81 cavans, the Azucena, 70 cavans and the Khao Bai Sri, 68 cavans as compared with 63.6 cavans of the local variety Murmuray, Binituen, 34 cavans and 59.2 cavans of Binalayang per hectare.

In a coöperative trial planting of Sipot dry season rice in San Manuel, Pangasinan, an average yield of 31.1 cavans per hectare was obtained in spite of the drought.

In the coöperative trial planting of Sipot within the Amburayan Irrigation System in La Union from the 72 coöperators an average yield of 51.4 cavans of palay per hectare was reported.

UPLAND RICE

Lamao Experiment Station, Lamao, Bataan

Variety test.—Of the 124 varieties of upland rice tested during the year the following led in yields: Kinastila with 31.42 cavans per hectare; Dinulis, 30.83; Derihon, 30.30; Brod-Sangupan, 29.65; Aslen, 26.67; Inangol, 24.28; Inintiw, 23.26; Pinilit, 22.42; and Kabuyok, 22.17.

Fertilizer experiments.—A combination of bone meal and superphosphate applied at the rate of 500 kilos and 180 kilos superphosphate per hectare gave a yield of 57.34 cavans, while a mixture containing 200 kilos of ammonium sulphate, 180 kilos of superphosphate and 500 kilos of bone meal gave 55.04 cavans per hectare as against 32.79 cavans of the check plots.

CORN

Lamao Experiment Station, Lamao, Bataan

Variety test.—Of the 27 varieties of corn tested the following gave the highest yields: Calamba Yellow, Moro White, Purple Flint, Matiao, Australian Dent, and Batangas Red, with an average yield of 20.64, 18.64, 16.49, 16.23, 15.58, and 15.46 cavans shelled corn per hectare, respectively.

Breeding test.—To purify the strains of Calamba Yellow, Moro White, and Cebu White, inbreeding tests were conducted. The Calamba Yellow produced 8 pure ears; the Moro White, 4; and the Cebu White, 13.

Green manuring.—By broadcasting cowpeas thickly during the wet season, plowing them under at flowering stage and allowing them to decay before planting, an increase of 30 per cent in yield was obtained. The average yield of corn in ears from the green-manured plot was 1,350.10 kilograms versus 1,038.50 kilograms from the plot left lying fallow.

FIELD INVESTIGATIONAL WORK

SUGAR CANE

La Carlota Sugar Cane Experiment Station, La Carlota, Occidental Negros

Acclimatization tests.—In growth the POJ–2878 exceeds the other varieties from Java, but it is also found to be attacked by the mosaic and Fiji diseases and besides it has a rather low purity. It arrows as early as September and October and because of its tall growth it is easily blown down by the wind so common in sugar-cane regions of the Islands.

DI–52 so far has shown good purity but it is also found to be the variety most susceptible to diseases and pests especially Fiji and the mosaic diseases. On the whole, however, this is a very good variety.

KE–28 looks like an ordinary cane. It has proved itself to be an early maturing cane, giving a high purity at the age of 11 months. The main objection to it is its susceptibility to mosaic.

SW–3 grows fairly well in poor soil and gives high purity at the age of 12 months.

EK–2 has proved to be well adapted to poor soil. When planted on a fertile soil it produces heavy cane with low purity. It matures at the age of about 13 months. The great objection to this cane is its susceptibility to mosaic disease and besides its leaves are not suitable for fodder.

Out of the other 101 varieties being acclimatized Co–214, Co–215, Co–281, Co–12797 and Toledo have proved they will grow well in poor soil, but all are susceptible to mosaic disease and give low purity.

The Malayan Striped No. 8, PB–117, PB–118, PB–119, PB–120, Pampanga Red, White Bamboo, and Zambales Red mature early. These canes are affected by mosaic disease, however.

Variety test of sugar cane (First ratoon—without fertilizer).—The five-year average yields per hectare in this test were as follows:

Variety name	Tons of cane per hectare	Piculs of sugar per hectare
Louisiana Stripped	55.00	101.75
Hawaii-109	61.06	101.00
Java-247	57.43	99.21
Badila	48.07	97.17
New Guinea 24-A	54.36	96.30
Hambledon-426	48.52	87.67
Yellow Caledonia	49.22	86.77
Negros Purple	45.63	84.96
Bordados-147	46.80	82.10
Luzon White	47.14	80.25
Rose Bamboo	45.15	74.80
Luzon Purple	40.27	70.68
Goru or N. G. 24	40.88	68.99
New Guinea-24-B	39.25	64.12

Variety test of (7 varieties) sugar cane.—Plant cane without fertilizer—They were harvested at the age of 12 months. Lc-22/4 gave the highest yield per hectare, 117.93 piculs of sugar; followed by HQ–429, 105.25; HQ–426, 93.50; Hambledon–426, 91.13; Negros Purple, 56.70; and Inalmon White, 55.19.

Variety test of (7 varieties) sugar cane—(First ratoon).—The canes were harvested at the age of 12 months. The production

in piculs of sugar follows: Negros Purple, 32.45 piculs of sugar per hectare; H. Queensland–429, 58.31; H. Queensland–426, 61.41; Lc–22/4, 64.33; Malagache, 48.92; Inalmon White, 37.57; and Hambledon–426, 62.71. The low yields were due partly to the poor conditions of the soil.

Variety test of (3 varieties) sugar cane.—The following shows the partial performance of the three varieties.

Variety name	Age	Brix	Sucrose	Purity
Negros Purple	12 months and 8 days	16.18	14.96	86.5
LC–25–191		17.17	15.14	88.4
DI–52		18.21	16.48	90.5

Ratooning power test of (4 varieties) sugar cane.—The test is still in progress but analyses of the canes in the fertilized plots show slightly lower purity than for the unfertilized ones which indicates that the unfertilized canes mature earlier than the fertilized ones.

Ratooning power tests of (14 varieties) sugar cane.—A second ratooning of 14 sugar-cane varieties showed that the Negros Purple was the poorest in growth both in the fertilized and unfertilized plots, on account of the fact that about 25 per cent of the cane was affected by "Negros Yellows." Java–247, Yellow Caledonia, Hawaii–109, New Guinea 24–A and Badila are good ratooners.

Stooling capacity test of (6 varieties) sugar cane.—The varieties used were Badila, Hambledon–426, Java–247, Lc–22/4, Negros Purple and New Guinea 24–A. The soil was quite poor but well drained. Java–247 produced the most stalks per stool and though it has the smallest stalks it gave the heaviest toal weight of stalks per stool. Badila had the heaviest weight per stalk and was second in total weight of stalks per stool, New Guinea 24–A came third in the total weight of stalks per stool.

Sugar-cane breeding.—Of the thousands of seedlings produced since 1921 some 2,247 seedlings are under a selection test. Of these Lc–21/2, Lc–22/4, Lc–24/138, Lc–25/191, Lc–25/229, Lc–25/476 and Lc–26/82 are the most promising. The Lc–22/4 is growing well in high and fertile soil, such as in Victorias, Manapla, and the Maao Districts and it gives a fair yield on poor soil. The average yield of this strain was found to be 146.93 piculs of sugar per hectare under La Carlota conditions without fertilizer. The Lc–25/191 seedling cane is favored by many cane planters at present.

During the 1929–30 flowering season there were 29 crosses made, which are expected to produce thousands of new seedling canes.

Sugar-cane soil investigations.—Lime to counteract the acidifying influence of ammonium sulphate—Plant cane of Badila was used in this test. The treatments were (1) fertilizing with ammonium sulphate at the rate of 250 kilos per hectare; (2) fertilizing with ammonium sulphate at the rate of 250 kilos and ½ ton of lime per hectare; (3) fertilizing with ½ ton of a complete fertilizer analyzing 10 per cent nitrogen, 6 per cent P_2O_5 and 2 per cent K_2O and ½ ton of lime per hectare. The 1928–29 results are as follows: Plots fertilized with ½ ton complete fertilizer (10–6–2) with ½ ton application of lime per hectare gave the highest yield, 149.25 piculs of sugar per hectare; with ammonium sulphate alone, 140.37 piculs; with ammonium sulphate and lime, 127.30 piculs; and the control, 107.22 piculs.

A comparative test of different brands of fertilizers on Badila.—The data obtained from 1928–29 crop were as follows: Control, 116.57 piculs of sugar per hectare; brand No. 1, 127.05; Brand No. 2, 134.36; Brand No. 3, 142.23; Mixture A, 142.89; Mixture C, 147.76; Brand No. 4, 143.10; Brand No. 5, 139.60; Brand No. 6, 134.32; Brand No. 7, 132.77; and Brand No. 8, 145.62. All plots with fertilizers gave higher yields than the control plot. Mixture C gave the highest yield, 31.19 piculs of sugar per hectare over the control.

A comparative test of different brands of fertilizers on Badila—First ratoon (1928–29).—The results obtained were as follows: Control, 59.89 piculs of sugar per hectare; Brand No. 1, 86.78; Brand No. 2, 100.39; Brand No. 3, 89.78; Mixture A, 114.68; Mixture C, 89.38; Brand No. 4, 98.14; Brand No. 5, 98.71; Brand No. 6, 87.31; Brand No. 7, 64.33; and Brand No. 8, 81.34. All plots with fertilizers gave higher yields than the control. Mixture A gave the highest yield, 54.79 piculs of sugar per hectare over the control.

A comparative test of phosphate and nitrogenous fertilizers combined and phosphate fertilizers alone—(Plant cane).—The test for the 1929–30 crop is still in progress. The fertilizer used per hectare were as follows: (1) 100 kilos nitrogen and 127.50 kilos P_2O_5; (2) 100 kilos nitrogen and 88.97 kilos P_2O_5; (3) 100 kilos nitrogen and 50.84 kilos P_2O_5; (4) 127.50 kilos P_2O_55; (5) 88.97 kilos P_2O_5; (6) 50.84 kilos P_2O_5. The results obtained from the 1928–29 crop were as follows: Plots fertilized with 100 kilos nitrogen and 127.54 kilos P_2O_5 gave the

highest yield, 145.37 piculs of sugar per hectare, or 57.77 piculs over the control plots. The 50.84 kilos P_2O_5 applied alone gave less yield than that of the unfertilized plots.

Time of application of ammonium sulphate at the rate of 50 kilos of nitrogen per hectare.—New Guinea 24–A was used in this test and planted 120 by 40 centimeters apart.

The canes were fertilized as follows: (1) at the time of planting; (2) 2½ months after planting; and (3) 5½ months after planting. The results obtained from the 1928–29 crop were as follows: Plots fertilized during planting gave the highest yield, 171.62 piculs of sugar per hectare; plots fertilized 2½ months after planting gave 154.56 piculs; and plots fertilized 5½ months after planting gave 146.12 piculs of sugar per hectare. The control plot yielded 117.15 piculs of sugar per hectare.

Crop rotation experiments.—Experiments on the 1929–30 crop are still in progress. The results for the year 1928–29 were as follows: Continuous planting of sugar cane gave 43.01 piculs of sugar per hectare; two plantings of sugar cane then corn then sugar cane gave 53.55; and two plantings of sugar cane then legume then sugar cane gave 48.01 piculs.

Cutting back stumps of sugar cane vs. noncutting on Badila (first ratoon).—The 1928–29 crop shows that noncutting gave higher yields in tons of cane and in piculs of sugar per hectare. The noncutting produced 3.61 tons cane or 7.42 piculs of sugar per hectare more than the cut back stumps. The costs of cutting back stumps of sugar cane per hectare in the station was ₱16.02, besides.

Hilling experiments.—The 1928–29 crop showed that hilled Badila stools do not give better yields than those not hilled.

The efficacy test of bolos.—The test was conducted at the station. The data obtained were as follows:

Kind of bolos	Number of men used	Weight of stalks cut in kilos	Time consumed	Weight of stalks cut per hour per man in kilos
Native	25	27,947	13 hrs. 44 min.	81,408
Hawaiian	25	35,466	14 hrs. 34 min.	97.392

FIELD INVESTIGATIONAL WORK

Germination tests.—Stalks of New Guinea 24–A at the age of 6 months and 22 days were cut into 4 lengths so that each cutting had three eye-buds. The cuttings are called apical, second, middle, and base. One thousand of each of these different por-

tions of stalks were planted in separate rows so that each row had 100 of each kind of cuttings. The percentage of germination were taken twice; first when the cuttings were a month old and the second when two months old. The results were as follows:

	Percentage of germination
Apical cuttings	90.8
Second cuttings	83.5
Middle cuttings	66.0
Base cuttings	54.7

Peanuts (Lamao Experiment Station).—In the variety test of peanuts of 6 varieties, Spanish and Vigan Lupog topped the list yielding 1,285.79 and 1,189.20 kilos of unshelled nuts per hectare, respectively.

TOBACCO

Ilagan Tobacco Experiment Station, Ilagan, Isabela

Acclimatization test of cigar wrapper varieties.—Of the light cigar wrappers of foreign varieties tested this year none has manifested qualities superior to those of the standard station wrapper varieties.

Acclimatization test of cigarette varieties.—Of the cigarette varieties of foreign origin tested during the year those performing most notably were the 104(9524) *Adcock,* 114(9528) *Pickett's White Burley,* and 107(9521) *North Carolina Bright Yellow.* The Turkish varieties are doing extraordinarily well but their generally small size will always be a strong handicap to their adoption by the farmers.

Miscellaneous acclimatization test.—During the year four German varieties and eight British-Indian varieties were tested. The German varieties thrived but none of the Indian grew, although about 5 per cent germination was obtained from the seeds.

Wrapper variety test.—In wrapper yields, 43(8293) *Philippine Sumatra* led with 38 per centum by weight, followed by 52(9731) *Vizcaya* with 33 per centum. The 18(8714) *Philippine-Florida-Sumatra* yielded 25 per centum. In total yield, however, the 52(9731) *Vizcaya* led with 1,456 kilos, the 18(8714) *Philippine-Florida-Sumatra,* and 43(8293) *Philippine-Sumatra* yielding 1,078 and 819 kilos per hectare, respectively.

Hybridization of cigarette tobacco.—Two crosses (Hybrid No. 1 and Hybrid No. 2) were under culture; Hybrid No. 1 (Romero x 43 Philippine-Sumatra) and Hybrid No. 2 (15 Romero x 10

Repollo (F_1, F_2, and F_3). No promising type has been segregated from Hybrid No. 1 but from Hybrid No. 2 a certain type was found to have great possibilities. Its leaves were extra big, light colored and aromatic.

Hybridization of wrapper tobacco.—Four new crosses were made this year: Hybrid No. 8 (43–*Philippine-Sumatra* x 52–*Vizcaya*), Hybrid No. 9 (18–*Philippine-Florida-Sumatra* x 52–*Vizcaya*), Hybrid No. 10 (9147–*Ilagan-Sumatra* x 52–*Vizcaya*) and Hybrid No. 11 (79–*Havanensis* x 12–*Pampano No. 1*). Those under culture were: Hybrid No. 3 (43–*Philippine-Sumatra* x 12–*Pampano No. 1* (F_1 and F_2), Hybrid No. 4 (43–*Philippine-Sumatra* x 18–*Philippine-Florida-Sumatra* (F_1 and F_2), Hybrid No. 5 (43–*Philippine-Sumatra* x 6–*Pampano No. 2* (F_1) and Hybrid No. 6 (79–*Havanensis* x 18–*Philippine-Florida-Sumatra*).

Cigarette variety test.—The three varieties used in the 1929 test, namely, 52 (8731) *Vizcaya,* 29 (8726) *Orinoko,* and 15 (8741) Romero, yielded a total of 1,230, 899.28, and 658.72 kilos of leaf tobacco per hectare, respectively.

Harvesting by priming and by cutting the whole stalk of cigarette tobacco.—Harvesting by priming or gradual picking of leaves as they ripen resulted in greater number, size, and yield of leaves harvested than harvesting by cutting the whole stalk. Curiously enough, however, while the range of the burning quality of the cut tobacco was big, the average was better than that of the primed. Variety 131–Turkish was used in the experiment.

Topping test with cigarette tobacco.—Topping the varieties 52 (8731) *Vizcaya* and 131-*Turkish* at the time the flower head began to appear by removing approximately one-third and one-half of the stalk from the apex was done. The production of leaves with a body similar to the genuine Virginia (0.11 millimeter thick) was obtained from the plants topped one-third from the apex.

Curing test with cigarette tobacco.—In an effort primarily to produce yellow cigarette leaf tobacco, seven different methods of curing were tried, using the varieties 52 (8731) *Vizcaya,* 15 (8741) *Romero,* 114 (9528) *Pickett's White Burley,* 29 (3726) *Orinoko,* and 130–*Samsun-Bafra.* Only the (8731) *Vizcaya,* 114 (9528) *Pickett's White Burley* and 29 (8726) *Orinoko* responded well to methods No. 7, No. 4, and No. 6, especially to No. 7. The methods tried were the following:

(1) Spaced (about ½ inch apart), stringing and curing entirely in the shade (normal or natural method or check).

(2) Spaced, stringing and four days' preliminary sun curing the rest of the time in the shade.

(3) Spaced, stringing and curing entirely in the open and completely sun curing.

(4) Tight sticking (native method with palillo) and two to four days' preliminary sun curing—the rest of the time in the shade.

(5) Tight sticking and complete sun curing.

(6) Tight sticking and curing entirely in the shade with controlled and gradually raised heat to 66° C.

(7) Spaced, stringing and curing entirely in the shade with controlled and gradually raised heat to 66° C.

Standardization test.—A test made with 14 supposedly distinct varieties received from 6 different regions outside the Cagayan Valley showed that 8 were identical with standard varieties of the station, one apparently new and the rest variable hybrids. With the exception of the one apparently new variety, none manifested any remarkable feature or characteristic.

Effect of different shading materials for wrapper tobacco.—Four materials, namely, (1) 36-mesh cheese-cloth, (2) 12-mesh cheese-cloth. (3) slatted bamboo, and (4) slatted talahib canes; and the varieties 65(8610) *Havanensis*, 52(8731) *Vizcaya*, and 43(8293) *Philippine-Sumatra* were used. Notwithstanding an outbreak of plant lice in the plots shaded with 12-mesh cheese-cloth, the varieties *Havanensis* and *Vizcaya* gave the highest percentage of wrapper, being 22 and 38 per cent, respectively, by weight. The other materials were: (1) 36-mesh cheese-cloth, (2) slatted bamboo, and (3) slatted talahib canes after the 12-mesh cheese-cloth. The results might have been better if the planting in connection with this experiment had not been too long delayed by the big flood of November, 1928.

Water requirement of tobacco.—The variety 12(9739) *Pampano No. 1* grew best at 80 per cent saturation in ordinary garden (clay) soil and at 60 per cent saturation in alluvial sandy loam soil. Five, 10, 20, 30, 50, 60, 80, and 100 per cent saturations were tried.

Pot fertilizer tests.—Using the variety 12(9739) *Pampano* No. 1 and employing the triangular system of fertilizer tests in the $8\frac{1}{3}$ per cent stages, the greatest growth was obtained from application at the rate of 20 kilos nitrogen, 80 kilos potash, and 140 kilos phosphoric acid per hectare.

Soil adaptability test for tobacco.—A pot experiment was made with two Cotabato virgin soils rich in humus, namely:

(1) cogon land and (2) second-growth forest land and five typical Isabela soils, namely: (1) clay soil, (2) alluvial loam (occasionally flooded old tobacco land), (3) clay loam (seldom flooded tobacco land), (4) silty loam (seldom flooded old tobacco land) and (5) alluvial sandy (yearly flooded old tobacco land). The 43–*Philippine-Sumatra* tobacco variety used grew best in Cotabato cogon soil where it reached an average of 107.5 centimeters in height and produced 20 leaves; in second-growth forest soil, 102 centimeters in height and 19.2 leaves; in alluvial sandy, 81.3 centimeters in height and 13.3 leaves; in clay loam, 28.5 centimeters in height and 8 leaves; and in the others, below 28 centimeters in height. This experiment points to an imperative need of extensive fertilizer tests in the Cagayan Valley.

Crop rotation.—The check plot which has been alternately planted to tobacco and corn since the beginning of the 1925–26 season, led in yield with 950 kilos of leaf tobacco per hectare. Plot 1, previously planted to corn—corn—corn—corn—native cowpeas, and corn gave 731.25 kilos; plot 2, to mongo—corn—native cowpea—corn—New Era cowpea—corn, 555.25 kilos; and plot 3, New Era cowpea—corn—native cowpea—corn—New Era cowpea—corn, 943.75 kilos. It appears therefore that legumes are not important for rotation purposes with tobacco. The variety used was 43–*Philippine-Sumatra.* The field is cropped twice yearly to maintain more or less perfect tilth.

Miscellaneous cultural experiments.—The use of pricked seedlings combined with thorough ridging cultivation yielded 944 kilos per hectare of which 116 kilos were wrapper; unpricked seedlings combined with thorough ridging cultivation 849 kilos of which 99 kilos were wrapper; pricked seedlings combined with ordinary plow cultivation, 637 kilos of which 69 kilos were wrapper; and unpricked seedlings combined with ordinary plow cultivation, 790 kilos of which 78 kilos were wrapper. The variety used was 43–*Philippine-Sumatra.*

Control of plant lice tests.—Using standard formulae singly or in combination, out of 32 tobacco plants sprayed in each case, only 2 plants were attacked after the application of (1) lead arsenate plus soap and (2) boiled tobacco decoction plus soap: 4 plants in (3) boiled tobacco decoction alone; 7 plants (4) unboiled tobacco decoction plus soap; 9 plants (5) soap alone; 10 plants (6) check (no application); and 15 plants (7) unboiled tobacco decoction alone.

Seed treatment for the control of tobacco diseases.—Employing certain standard disinfectants, the seeds dusted with (1)

disinfectant (No. 1) produced the biggest and cleanest seedlings; those immersed in (2) normal solution, (No. 1), the next best seedlings; those immersed in solutions of (3) corrosive sublimate, (4) silver nitrate and (5) formaldehyde produced seedlings less diseased than the (6) check (untreated) seeds although the growth was practically the same in (3), (4), (5), and (6).

Coöperative trial planting work.—Coöperative planting work on tobacco was greatly handicapped by the big flood of last year. However, a cigarette tobacco coöperator in Tuguegarao, Cagayan, succeeded in producing some yellow leaves which he sold at ₱20 per quintal when the highest price paid to others in his vicinity was ₱12 only.

Sarunayan Tobacco Experiment Station, Cotabato

Wrapper variety tests.—As in the previous tests, 14–*Philippine-Sumatra* gave the highest percentage of wrapper, which was 37.7 per cent, followed by 29–*Bx-hybrid*, 32.7 per cent; 24–*Philippine-Sumatra* 21.0 per cent; 25–*Philippine-Sumatra*, 19.3 per cent; and 30–*Ax-hybrid*, 18.9 per cent. The 1–*Philippine-Florida-Sumatra* was found to be very susceptible to mosaic and Cercospora disease and insect pests.

Seasonal planting tests with wrapper tobacco.—This test plays an important part in the determination of the causes of the greenish spots which have always characterized the leaf tobacco produced at the station. The wrapper varieties (or strains)—14–*Philippine-Sumatra* and 1–*Philippine-Florida-Sumatra*, were used in the three series of plantings (at 15 days intervals) October 23, November 7, and November 22, 1928.

Of the three plantings the first and second plantings showed a more less uniform vigorous growth while the planting made during the latter part of November showed a rather uneven stunted growth due to the wet condition of the soil.

As to yield and quality of the crop produced the following results were obtained: first planting—14–*Philippine-Sumatra*, 924.76 kilos per hectare, 21.43 per cent wrapper; second—657.61 kilos, 19.32 per cent; and third—469.97 kilos, 16.33 per cent wrapper; first planting—1–*Philippine-Florida-Sumatra*, 1,062.78 kilos per hectare, 8.47 per cent wrapper; second—1,000.73 kilos, 14.88 per cent; and third—1,368.61 kilos, 19.31 per cent wrapper. More spotted leaves were produced from the second planting than from the first and third plantings. This was due to the fact that it was rainy and foggy during the latter part of November and during December, with an average monthly precipitation of 114 and 160 millimeters, respectively.

A study of different cultural systems of planting tobacco (by bed, ridge, and hill systems).—Using the 24–*Philippine-Sumatra* variety with these systems of culture, the following results were obtained: (*a*) bed system; 28.10 per cent wrapper, 982.90 kilos per hectare; (*b*) ridge, 26.90 per cent, 929.50 kilos; and (*c*) hill system, 17.00 per cent, 688 kilos. The ridge system, however, gave 13.20 per cent and nonspotted leaves; the bed system, 12.60 per cent and the hill system, 6.70 per cent.

Green manuring experiment with wrapper tobacco.—Two wrapper varieties—14–*Philippine-Sumatra* and 1–*Philippine-Florida-Sumatra* were tested for the effect of cowpeas as a green manure. The 14–*Philippine-Sumatra* in the plot previously covercropped with cowpeas grew to an averaged height of 147 centimeters and yielded 552.44 kilos of which 26.85 per centum were wrappers per hectare while in the control plot, the average height was 124 centimeters and the total yield, 279.44 kilos of which 20.06 per centum were wrappers. The 1–*Philippine Florida-Sumatra* in the corvercropped plot averaged 173 centimeters in height and yielded a total of 1,113.67 kilos per hectare, the percentage of wrappers being 16.15 while in the control plot its average height was 151 centimeters and the total yield, 461.11 kilos per hectare of which 21.48 per centum were wrappers.

FORAGE CROPS

Lamao Experiment Station, Lamao, Bataan

Fertilizer test.—A fertilizer test on barit was conducted by applying copra meal at the rates of 800 kilos, 1,000 kilos, and 1,200 kilos to the hectare. The experiment is in progress and only one cutting has been made so far, after two months of growth, the computed yields being 5,415.50 kilos, 7,623.36 kilos, and 8,223.86 kilos of green fodder per hectare, respectively, against 4,582.57 kilos (average yield) form the control plots.

A fertilizer experiment on balili (barili) grass has been started by using copra meal at the rate of 1,200 kilos to the hectare. The experiment is in progress and only one cutting was made so far, after 2½ months, the yield being 7,995.34 kilos of green fodder to the hectare against 3,700 kilos from the control.

Hay making.—An experiment on making hay from manimanihan (manimanian) was conducted so as to store this native

forage and utilize it in case of a scarcity of green fodder. Cutting the stems while yet tender has been found to produce good hay. The fodder was first wilted in the sunshine for a day after cutting, then put in the shade for final drying. After the fodder was air-dry, it was stacked to keep the leaves green. The manimanihan hay was found to be well relished by horses. The quantity of fresh fodder obtained from a hectare of manimanihan was 11,400 kilos, which gave 1,700 kilos of hay.

Miscellaneous forage investigations.—In the vicinity of Manila barit growing in the fields where irrigation water and fertilizers are used, has been found to be quite a profitable business since it yields from 10,000 to 40,000 kilos per hectare annually.

Of the countless pasture grasses widely scattered all over the Philippines, balot (luya-luya in Tagalog), *Panicum repens;* Saladens, *Panicum humile;* and Malacauayan, *Panicum distachyum* have been found capable of adapting themselves to produce fairly good pasturage in sandy places where other grasses fail to grow.

FIBER PROJECTS

ABACÁ

Guinobatan Abacá Experiment Station, Binogsakan, Guinobatan, Albay

Variety-test of abacá (11 varieties):

Lausigon yielded 561.08 kilos fiber per hectare (third year crop).
Samina yielded 638.99 kilos fiber per hectare (third year crop).
Bulao yielded 484.77 kilos fiber per hectare (third year crop).

The rest of the varieties, including Maguindanao, gave a yield ranging from 330.43 kilos to 395.93 kilos per hectare. The tallest variety was Samina followed by Lausigon and Inisarog.

As to tensile strength of the fiber the varieties in the order of their strength are:

	Grams per gm-m.
Itom	61,332
Puti-tomatagacan	58,732
Bongolanon	57,522
Inisarog	55,520
Tangongon	53,799
Maguindanao	52,846
Lausigon	52,526
Bulao	51,343
Libutanay	51,313
Samina	45,274
Canarahon	45,224

Different methods of preparing land for planting abacá of the Itom variety, third-year crop)—

(*a*) Cleared, plowed field yielded 273.32 kilos per hectare.

(*b*) Cleared, not plowed field yielded 247.94 kilos per hectare.

(*c*) Noncleared and nonplowed field yielded 340.67 kilos per hectare.

In (*a*) the harvest increased by 7.68 kilos while in (*b*) it lost 14.33 kilos, and in (*c*) it also lost 101.6 kilos over the previous year.

Shading experiment with abacá second-year crop).—Shaded Samina produced 277.8 kilos per hectare or 5.04 times more fiber than plants of the same variety planted in the open field (which produced 55.56 kilos per hectare).

Distance of planting for abacá using the Itom variety (second-year crop).—The following results were obtained during the year:

	Quantity of fiber produced	Increase over previous year
	Kilos	*Kilos*
1.5 meters apart	573.63	43.56
2.0 meters apart	392.66	224.90
2.5 meters apart	364.83	274.72
3.0 meters apart	306.69	159.78
3.5 meters apart	263.73	169.45

As to tensile strength, a preliminary result giving an average of 66,397 grams was obtained for trees 1.5 meters apart; while for trees 3 meters apart an average of 63,494 grams was obtained.

Cultural methods for abacá plantation using itom variety (second-year crop).—The abacá plots where the weeds were cut down with a bolo and sickle every four months gave 786.6 kilos of fiber to the hectare; while the average yield of the three plots cleaned with the same tools once every 8 months was only 529.9 kilos per hectare.

Harvesting tests.—In harvesting abacá (Itom variety) by what is known as the "pujada" system (i. e. harvesting all big stalks) it required one year and eight and a half months before another harvest could be gathered from an area of 1,300 square meters which produced 1,654.6 kilos (only one harvest) of coarse fiber, while from a similar area harvested in the ordinary way (3 times a year), a yield of 909.98 kilos per hectare was obtained for the same period. But the effect of the "pujada" system is to make the stalks smaller and shorter in subsequent

harvests and cause more stunted stalks which are known as "taguiltil."

A study of the fiber contents of abacá plants at different ages using Itom variety—

One year and three months old plants contain an average of 0.98 per cent fiber.

One year and six months and six days contain an average of 0.83 per cent fiber.

One year and eight months old contain an average of 1.10 per cent fiber.

One year and ten months old contain an average of 1.26 per cent fiber.

Two years old contain an average of 1.10 per cent fiber.

Two years and three months and three days contain an average of 1.19 per cent fiber.

Two years and six months contain an average of 1.19 per cent fiber.

A preliminary test of tensile strength has been performed with the following results: for abacá plants one year and three months old, 54,235 grams per gram meter; for abacá plants one year and six months old, 58,039 grams per gram meter; and for abacá plants one year and eight months old, 58,214 grams per gram meter have been obtained.

A test of the thinning of hills of unhealthy suckers—Itom variety.—A slight increase in yield was registered in plots where the hills had had their unhealthy suckers removed.

PLANTING TESTS OF DIFFERENT SIZED SUCKERS AND ROOTSTOCKS OF ABACA

(Using Itom variety)

Size of planting materials	Time of maturity from planting	Amount of coarse fiber produced per hectare
	Days	*Kilos*
Suckers ½ meter long	1,002	16.75
Suckers 1 meter long	1,002	129.93
Suckers 1½ meters long	848	147.43
Suckers 2 meters long	695	312.96
Suckers 2½ meters long	485	457.96
Rootstocks ¼ section	1,002	31.57
Rootstocks ½ section	1,002	27.05
Rockstocks entire small	1,002	32.73
Seeds (from date of sewing in boxes)	1,425	([a])

[a] Results not yet reported.

Fertilizer test No. 1 on old abacá plantation using Itom variety.—The application of calcium phosphate containing 26 per cent P_2O_5 at the rate of 50 kilos per hectare gave a yield or 611.6 kilos of fiber and the application of 200 kilos of nitrate of soda and 600 kilos of copra cake gave a yield of 598.3 kilos per hectare, while the check plots gave an average yield of 546.6 kilos per hectare, all in one harvest.

Fertilizer test No. 2 on old abacá plantation using Itom variety.—An application of 576 kilos of a fertilizer mixture containing 16.45 per cent N and 20 per cent P_2O_5 per hectare gave a yield of 916.7 kilos of fiber per hectare while the check plots gave an average yield of 673.3 kilos per hectare only.

Fertilizer test No. 3 on old abacá plantation using Itom variety.—The three fertilized plots which gave the highest average computed yields of course fiber per hectare (one harvest) were as follows: (*a*) plot 3–treated with 500 kilos of copra cake per hectare yielded 821.44 kilos; (*b*) plot 33–receiving a mixture of 300 kilos ammonium sulphate (26.6 per cent N.) and 50.8 kilos of superphosphate (19.65 per cent P_2O_5) produced 797.48 kilos; and (*c*) plot 11–same as in (*a*) but 50.8 kilos of superphosphate added gave 760.7 kilos. The nine check plots (no fertilizer) produced an average computed yield of 563.62 kilos of same fiber per hectare.

The effect of fertilizer on young abacá seedlings using Itom variety.—The fertilized seedlings are still small and no definite results can be reported except that those treated with ammonium sulphate produced dark green leaves. The sulphur treatment showed yellow coloration with stunted growth compared with the check. Other fertilizers applied singly, like superphosphate, "ligia" by-product, and guano made no gain for the plants in the check plots.

Fertilizer test on renewed Itom abacá plantation.—A fertilizer containing 12 kilos N., 78 kilos P_2O_5, and 29 kilos K_2O, produced 574.66 kilos of fiber per hectare; 78 kilos of P_2O_5 gave 561 kilos; and 60 kilos of potassium sulphate alone gave 262.66 kilos, while the average yield of the check plot was 292.27 kilos of fiber per hectare.

Abacá breeding work.—During the year, 17,075 hybrid seedlings were raised from 13 different crosses and a greater number of the hydrate seeds are still in the seed flats.

A study of pollination on abacá.—Using the Itom variety as the female parent and the Lausigon as the male, and performing pollination at 5 different times of the day, it was found from the three tests made that pollination at 8 and 10 a. m. gave the highest percentage of developed fruits. With natural cross-pollination by insects, which as a rule takes place in the morning, the average was 95.24 per cent.

Cover-cropping experiment with abacá.—Preliminary results on the height of 128 stalks of the Itom variety shows that the plots with *Tephrosia candida* and Lyon bean had an average

height of 53.1 and 55.5 centimeters, respectively, as against 47.5 centimeters for the plants in the check plot.

Green manuring experiments with abacá using Itom (about 6 months old).—The green-manured plants (with cowpeas) were 63.0 centimeters high, while the check plants measured 52.4 centimeters high.

Effect of delaying the stripping of "Binacnes," using variety Itom.—The results of the first test using knife No. 40 were as follows: Immediate stripping produced 34.01 per cent E, 19.83 per cent F, 27.93 per cent J1 and 18.22 per cent S1 fibers; stripping 1 to 4 days later gave an average of 16.28 per cent G, 19.27 per cent H, and 38.89 per cent J1; stripping five to six days later gave an average of 74.88 per cent G and 25.12 per cent H.

Grades produced by delaying the stripping of cut stalks.—The results of the first test using knife No. 40 were as follows: (1) Variety Itom, immediate stripping produced 64.65 per cent E, 18.55 per cent F, and 16.80 per cent S3 fibers; stripping 4 days later gave 27.55 per cent F, 50.22 per cent I, and 22.12 per cent S3; stripping eight to 32 days later generally 32.8 per cent S3, and 67.13 per cent G. (2) Variety Puti-tomatagacan, immediate stripping produced 17.16 per cent S2, 70.32 per cent I, and 12.52 per cent F; stripping four to 16 days later gave an average of 16.15 per cent S3, 63.14 per cent I, and 20.71 per cent F; stripping twenty-eight to 32 days later gave an average of 21.95 per cent S3, 34.14 per cent S2, and 43.91 per cent S1.

Efficacy test of stripping knives.—The average results from two tests were as follows: Knife No. 24 stripped 23.78 per cent H, 29.09 per cent G, and 47.13 per cent J1 fibers; knife No. 30 produced 24.37 per cent F, 22.17 per cent I, 32.22 per cent J2, and 21.24 per cent S2; knife No. 40 gave 77.12 per cent F and 22.88 per cent S1; knife No. 46 produced 19.75 per cent D, 60.24 per cent E, and 20.01 per cent S1; and knife No. 0 stripped 30.56 per cent E, 47.31 per cent G, and 22.13 per cent S1.

Grades produced by delaying the drying of stripped fiber and its effect on the tensile strength, Itom variety used.—With the use of knife No. 40 the results were as follows: Drying immediately gave very white and lustrous fiber producing 1.37 per cent of fiber per stalk with a tensile strength of 63,170 grams per gram-meter; drying 12 hours later gave 1.18 per cent of white fiber having a tensile strength of 54,186 grams per gram-meter; drying 24 to 60 hours later produced light-brown to dark-brownish fiber of 1.09 to 1.05 per cent by weight with an average tensile strength of 51,066 grams per gram-meter.

A comparative test of preparing "Tuxies." Itom variety used.—Lots of 40 stalks weighing 272.85 kilos each required an average of 3 hours to prepare "binacnes" weighing 45.15 kilos and 2 hours 25 minutes to prepare "lucknet" weighing 50.6 kilos. To strip both under knife No. 24, it took 2 hours, 20 minutes for the former and 2 hours, 39 minutes for the latter. The "binacness" gave 2.25 per cent fiber more than the "lucknet."

Drying test on abacá fiber, using variety Itom.—With equal weights of fresh fiber stripped with knife No. 40, the results show that fibers dried under the shed gave the heaviest weight; the sundried was second, but whitest in color; and the fibers left exposed to the rain for two days gave the lowest weight and with some brownish fibers.

Abacá production as offected by different types of soil, using variety Itom.—From three separate plots having an area of 2,500 square meters each representing distinct types of soil, the results showed that sandy loam produced the highest, followed by clay loam and then by fine sand-loam with the corresponding computed yields of 357.6, 348, and 142 kilos of coarse fiber per hectare.

SPECIAL FIELD INVESTIGATIONS

A preliminary investigation conducted in the station from the different experimental plots about the production of "taguiltil" (small, slender and undesirable abacá suckers) shows the following: (*a*) that close planting and heavy harvests of suckers favor rapid production of "taguiltil"; (*b*) that open fields have more tendency to produce them than the shaded fields; (*c*) that soil helps much to put them under control to some extent; (*d*) that rootstocks as planting materials produce more of them than suckers; (*e*) that old plantations produce more than rejuvenated ones; and (*f*) that the application of fertilizers on old plantations did not show any visible good effect in the control of same.

Abacá special field investigation in Davao.—Maguindanao, Tangongon, and Bongolanon are the three best abacá varieties extensively cultivated on mostly level and rolling fertile lands. Mixed planting of these varieties in one field is not practised. All the abacá plantations visited are without shade trees.

Abacá plants in Davao mature in 18 to 20 months from planting. Harvesting of mature stalks is usually done three times a year in the Japanese and American fields and twice a year in the fields of Filipino planters.

A Japanese plantation is now experimenting on the use of fertilizers imported from Japan. Green manuring is just being started also on renewed fields.

The abacá fields of two Japanese plantations have irrigation systems which are seldom used on account of the high cost of operation. The power of the irrigation water in both plantations is used to advantage in running small stripping machines, stone crushers and electric and ice plants.

Clearing the forest for a new abacá plantation is usually done under contract by Japanese laborers. The cost per hectare is approximately ₱170. The total cost per hectare from clearing up to maturity of the plants ranges from ₱300 to ₱450.

Rootstock sections containing one or two healthy buds from picked mature plants are the only kind of planting material used, and the planting distance is three by three meters; suckers are never used except for replanting. Mulching abacá fields is not practised except in one Japanese plantation where an experiment on the use of abacá waste from a certain stripping machine (No. 1) for mulching purposes is being conducted. Cover-cropping is practised during the first year in all plantations visited. Cowpea and the Japanese bean called "Taratsome" are used, especially the latter.

Stripping is done ordinarily with the small Japanese stripping apparatus run by a 1½ horse-power engine or sometimes by water power, with a daily output ranging from 1½ to 2½ piculs of fiber with good cleaning. The stripping machine (No. 1) produces about 25 piculs of "Deco" fiber a day. Then another stripping machine (No. 2) produces from 30 to 50 piculs per day of "Deco" fiber of good quality.

An estimate on the actual cost of harvesting and stripping runs close to ₱9 per picul of fiber under good cleaning.

The minimum estimate of the annual production per hectare is eleven piculs. Some records, however, show an average yield of 18 to 22 piculs per hectare from plantations about 10 years old.

Renewing abacá plantations 15 to 20 years old is a common practice among the Japanese and American planters. It pays more to renovate than to keep old plantations. No serious abacá diseases and pests are known in Davao.

Landlords receive from the Japanese tenants who lease their lands for 15 years 10 per cent of the value of the hemp sold.

Special abacá field investigation in Mindoro.—The abacá varieties grown in Mindoro are Luno, Tabono, Itom, Samoro, Si-

nagilala, Sinibuyas, and Kinalabaw. Luno is the most widely cultivated there. This variety is easy to strip, is productive and the fiber is white, lustrous, and long.

MISCELLANEOUS FIBER CROPS

Lamao Experiment Station, Lamao, Bataan

KAPOK

Acclimatization tests.—Eleven Java kapok trees about five years old (Var. Haden) fruited for the first time, giving a total of 137 matured pods. T4R2 planted 6 meters apart yielded 37 matured pods, the highest individual yield per tree so far obtained from the Java kapok.

Distance of planting tests (native kapok).—The computed yields per hectare for trees 5 meters apart, 5.5 meters apart and 6 meters apart were 9,600 pods, 10,560 pods, and 8,587 pods, respectively.

Selection tests.—Some 11,443 matured pods from 513 trees were harvested during the year. T5R7 planted 6 meters apart produced 108 pods, the highest individual tree record this year. T12R7 distance 5.5 meters apart produced 93 pods, the second highest individual tree record.

AGAVES

A comparative experiment on fiber extraction methods with different species of agave was conducted and the following are the results:

Retting experiments	Knife stripped fiber	Salt water retted fiber	Semi-salt water retted fiber	Fresh water retted fiber	Length of fiber	Color
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Cm.*	
Maguey	1.50	2.84	4.11	11.74	113	White.
Sisal	2.46	1.56	1.93	3.43	107	Do.
Henequen	1.80	2.12	3.70	1.92	110	Dull white.
Agave Zapupe	3.00	7.50	2.40	6.00	83	White.
Agave sp.	2.00	1.25	6.40	2.66	72	Whitest.
Mauritius hemp	0.41	0.40	1.20	0.80	117	White.

This experiment is still in progress.

ROSELLE

Selection tests.—From a test made of the fiber variety of white roselle (*Hibiscus sabdariffa,* var Altissima), an average content of fiber per stalk of 8.07 per cent was found; and that it took the bark 15 days to ret in salt water. The fiber had a length of 1.45 meters.

COTTON

Hybridization.—The cotton crosses of Trice with Kapas-Purao produced in 1928 were planted. At three months old they began to produce but the bolls are still immature.

HORTICULTURE PROJECTS

MISCELLANEOUS HORTICULTURE

SPECIAL FIELD INVESTIGATIONS

CITRUS

Variety test of mandarin oranges.—There are 29 varieties and strains of mandarin orange in this test, with 554 tress grown. The 10 varieties averaging the most fruits borne this year are the Szinkom (P. I. 1267) yielding 328.8 fruits at 6 years of age; Oneco (P. I. 1335) 134 fruits at 6 years; Saagkam (P. I. 5163) 92.7 fruits at 6 years; Dancy (P. I. 1918) 63.3 fruits at 6 years; China (P. I. 1265) 60.1 fruits at 5 years; Malvar (tizon) (P. I. 5183) 58.9 fruits at 6 years; King (P. I. 2693) 58.0 fruits at 6 years; Rafael (tizon) (P. I. 5143) 54.6 fruits at 6 years; Kishiu (P. I. 1271) 50 fruits at 6 years; and Batangas (P. I. 8868) 41.5 fruits at 8 years of age.

These varieties are rated in the following order in regard to their eating qualities: Kishiu, Batangas, Dancy, Oneco, China, Szinkom, King, Malvar (tizon), Rafael (tizon), and Saagkam.

All of these varieties, excepting the Saagkam, can be recommended for commercial planting, considering the order of their importance in regard to their prolificacy, as follows: Szinkom, King, Lancy, Oneco, Batangas, China, Malvar (tizon), Rafael (tizon), and Kishiu. The Ladu mandarin orange (P. I. 1256) is also considered a very promising variety.

A variety test of sweet oranges.—There are 150 trees in all representing 12 varieties. Although this test was started only one and a half years ago a few trees of the Homosassa, Laurel and the selected orange No. 7 have fruited. The trees are progressing satisfactorily with the continuous covercrop—no tillage system of culture.

A variety test of pummelos and grapefruits.—There are 175 trees consisting of 9 varieties planted for the test which was started in June, 1928. The trees are thriving under the continuous cover crop-no tillage system of culture.

A variety test of lemons and limes.—There are 46 trees planted in this test. This test was started only a year and a half ago, and no results can be reported yet. However, the trees are

doing well under the continuous cover crop—a tillage system of culture.

Selection test of superior Batangas mandarin types.—Out of the 15 selections grown in our cultures, the following are considered the most valuable: P. I. 8865, P. I. 8868, A–10, 877, DI87, and B298. The last named is a sporting branch of the tree carrying that number.

A stock test for pummeloes.—For the Siamese "seedless" pummeloes, the Batangas mandarin orange and the sour orange have been found to be the most suitable stocks; for the Saigon pumelo (P. I. 3384), the rough lemon stock produced the heaviest yield; while the Nueva Ecija pumelo (P. I. 7410) trees have grown very well on pumelo stocks. As a general rule, the Batangas mandarin orange, the sour orange and the pummelo are the most preferable stocks for the pummelo scions.

A stock test for the grapefruit.—The amount of data on this is meagre at present. However, all the data secured from the plantings of this station, where different stocks have been used show that the grapefruit grows well on Batangas mandarin orange and rough lemon stocks.

A stock test for oranges.—The Calamondin, the Batangas mandarin orange and the rough lemons were extensively used as stocks in this test. From the data available at present, the most desirable stocks for the orange are the Batangas mandarin-orange and the calamondin. The sweet orange grows well on rough lemon stock but is not productive of high quality fruits, while the calamondin stock is more weakly rotted than the Batangas mandarin orange stock.

A stock test for mandarin orange.—Calamondin, Chinese orange, Batangas mandarin orange, sour orange, pummelo, rough lemon and wild orange were used as stocks in this test. In general, the Batangas mandarin orange, rough lemon, sour orange and calamondin stocks have been found satisfactory, in the order named.

A stock test for lemon.—The calamondin, rough lemon, sour orange, and the pummelo were used as stock in this test. The rough lemon has been found to be the best stock for the lemons, with the pummelo and sour orange stocks ranking as next best alternatives. The calamondin proved to be an uncongenial stock for the lemons, producing trees which gummed easily and were, therefore, short lived.

A stock test for lime.—The calamondin, rough lemon and Batangas mandarin orange stocks were used in this test. The calamondin proved to be a satisfactory stock for the Everglade, Kusaie, Native, and Trinidad limes, but was a poor stock for the Tahiti lime which developed satisfactorily on Batangas mandarin-orange and rough lemon stocks.

Fertilizer and lime tests on old Batangas mandarin-orange trees.—The lot given complete fertilizer, plus lime, was the highest yielder, giving an average yield of 1,583.5 fruits per tree this year. The check lot gave only an average yield of 1,265.5 fruits per tree. The gain in yield of the fertilized lot over the check was 64,872 fruits per hectare of 204 trees. At ₱20 per 1,000 fruits this gain would represent a value of ₱1,297.44. The cost of the fertilizer and lime applied was ₱129.09, and the cost of labor for applying and incorporating them in the soil was ₱40.80, making a total expenditure for manuring of ₱169.89 per hectare. There would then be a net gain of ₱1,297.44–₱169.89—₱1,127.55 per hectare due to the use of fertilizer and lime.

Fertilizer and lime tests on young budded Batangas mandarin-orange trees (P. I. 8868), 7 years old.—The lot given a complete fertilizer but no lime, using bat guano as the source of phosphoric acid, gave the highest yield, with an average of 150.5 fruits per tree. The corresponding check lot gave only 66.0 fruits per tree. The gain in yield of the fertilized lot over the check was 22,406.5 fruits per hectare of 277 trees. At ₱20 per 1,000 fruits, this gain would represent a value of ₱468.13. The cost of the fertilizer used was about ₱85 and the cost of the labor for applying it ₱40.80, making a total expenditure for manuring of about ₱125.80 per hectare.

There would then be a net gain of (₱468.13—₱125.80), ₱342.33 per hectare due to the use of the fertilizer.

Citrus hybridization.—From the 250 flowers crossed during the year, 14 hybrid fruits were produced. Hybrid seedlings from S. S. Pummelo x King mandarin-orange; Orange No. 10 x Kishiu mandarin-orange; and Szinkom mandarin x Batangas mandarin-orange; crosses, are now growing.

The effect of cover crop on the ripening of Batangas mandarin Oranges.—The plots having ipil-ipil and *Tephrosia candida* cover crops matured very early—the mandarin oranges showing full maturity on November 25, 1929, whereas the fruits in plots

having cacahuate for a cover crop did not attain the same stage of maturity until at least 2 weeks later.

The early fruits ripened at least one month ahead of mandarin oranges grown outside the station, in the whole Province of Batangas.

Lamao Experiment Station, Lamao, Bataan

Stock tests.—The 708 Lisbon lemon budded on the sour orange stock gave the best growth and the greatest diameter of crown, 2.17 meters and 1.7 meters, respectively. The 1636 Washington Navel orange budded on the ganid (*C. webberi*) stock was first with 1.51 meters, and 1.5 meters, respectively. The 3673 Siamese "Seedless" pomelo budded on the ganid (*C. webberi*) stock was first with 1.6 meters and 1.5 meters, respectively. None of the aforementioned scions have fruited so far.

Variety tests.—The variety tests of oranges and pomeloes consisting of 13 and 7 varieties, respectively, have now been in progress for 4 years but no definite results are so far to be recorded. However, of the oranges one plant of the 1637 Jaffa budded on Calamondin produced 2 fruits; one of 1639 Ruby on Calamondin, 1 fruit; one of 2689 Enterprise on Calamondin, 7 fruits; two of 4123 Magnum Bonum on Calamondin, an average yield of 4.5 fruits; and two plants of 4119 Dugat on Calamondin, an average yield of 4 fruits. The forgoing data show that Calamondin stock has a tendency to effect the early bearing of oranges. None of the pomeloes has fruited so far.

COFFEE

A comparative yield test of coffee.—Taking the actual yields of clean coffee a hectare of the different coffee varieties planted at the Lamao Experiment Station the following results were obtained:

On fairly good land the Excelsa coffee planted 13 years ago yielded 472.71 kilos of clean coffee per hectare; the Liberian coffee, 12-year old, 363.17 kilos; and the Dybowskii, 10-year old, 76.28 kilos.

Coffee cup test.—The Liberian (big berries) gave the strongest caffeine odor and taste; Liberian (small berries), second; Excelsa (small berries), third; Excelsa (big berries), fourth; Robusta, fifth; Canephora, sixth; Abecouta, seventh, and Dybowskii the last.

Coffee hybridization.—The hybrid seedlings between Liberian and Excelsa planted in 1927 at Lamao are in good condition

but they have not fruited yet. Hybrids between Liberian and Arabian coffee, Excelsa x Arabica, etc., have been produced and the seeds are now in seed flats.

Topworking with coffee.—The Excelsa, Arabian, and Robusta scions in the top-worked Dybowskii trees are now in excellent condition.

AVOCADO

Acclimatization test.—The two avocado orchards of this station have 224 living plants consisting of 43 varieties as against 219 plants of 43 varieties last year. For the 19 avocado trees that fruited this year a total of 787 fruits were recorded, or an average of 41 fruits per tree. The yield varies from 6 to 175 fruits per tree.

Variety test.—Two seedling trees of Cyrus and Avocado No. 1 4½ years old in the variety test orchard fruited for the first time this year with 16 and 9 fruits, respectively.

Marcotting.—After several years' trial of marcotting the avocado, this year about 50 per cent success was attained.

BANANA

Variety test.—Of those that have fruited so far in the variety test the Latundan, Lacatan, Buñgulan or Tampuhin, Morado, Saba, and Gloria have been found to be the best varieties. Matabia gave the highest computed yield per hectare of 16,036.88 kilos; Sabang-Iloco, 15,357.81; Ideep, 15,105; Tarnate, 13,744.063; Baja Malacca, 12,377.19; Katali, 12,333.75; Gapis, 11,037.50; Pisong-Abhu, 8,309.28; Chinese Dwarf, 5,846.88; and Belludo. 5,739.06.

MANGO

Stock tests.—As far as growth is concerned, the following results were obtained from the stock tests. For grafting, Carabao is best and Pico next for Carabao scions; Carabao is best and Pahutan next for Pico scions; Carabao is best and Pahutan next for Pahutan scions. For budding, Pahutan is best and Carabao next for Carabao scions; Pahutan is best and Carabao next for Pico scions; while Carabao is the only one tried so far for Pahutan scions and no results have as yet been obtained.

Forcing mangoes to fruit.—It took about 15 days to smudge and produce the flower buds on 8-month old and 7 to 9 days on one-year old twigs. From the smudged trees eleven produced 8,139 fruits, or an average of 737 fruits per tree.

RIMAS

Marcotting.—In marcotting rimas seedlings in the nursery shed and on fruiting trees in the field 100 per cent and 25 per cent success was obtained, respectively. It took from 31 to 42 days for the seedlings and about 89 days for the fruiting trees before the marcotted branches could be separated.

Budding and grafting.—Trial budding of Rimas on Gomihan was done and of the two buds inserted one is now sprouting. Other vegetative methods such as bottle grafting with water and with moss were tried but did not succeed.

ROOT CROPS

Sweet potatoes.—There were thirteen varieties of sweet potatoes planted this year under the variety test but no harvest has so far been made from them. From the last year's planting which was harvested in January, 1929, the following varieties gave the highest yields in kilos per hectare: (1) Hawaii, 8,950.6; (2) Momungan, 8,746.1; (3) Laoc, 8,507.4; (4) Guinobatan, 8,382.8; (5) Shealley, 8,232.6; (6) Kalamias, 7,396.4; (7) Bacongan, 4,452.9; and (8) Jersey, 4,452.9.

Tugui.—From the culture under variety test of tugui harvested January, 1929, the following gave the best yields in kilos per hectare: (U–15), 14,160 kilos; (10–10), 14,000; (10–11), 13,750; Akang, 12,580.6; (U–4), 12,413.2; (1817), 12,222.2; (1014), 13,636.0; and (1050 A. M.), 12,857.1.

Gabi.—Under variety test of gabi planted in rows 1 meter by 50 centimeters, the following yields in kilos per hectare were obtained: (1) Semet B, 14,791.6; (2) Gabi No. 4, 13,142.8; (3) Yautia B, 10,095.2; (4) Semet A, 12,856.8; (5) Surigao, 11,224.4; (6) Tanay, 10,714.2; and (7) Yautia A, 10,000.

Ubi.—Of the varieties of ubi subjected under the variety test last year and planted at a distance of 1 meter by 1 meter the following were the yields in kilos per hectare: (1) L. E. S. No. 1, 9,347.8; (2) U–D, 7,812.5; (3) Sinawa A, 7,407.4; (4) Kinalabao, 5,625.0; (5) Sinawa B, 6,086.9; (6) Basol, 5,740.7; and (7) Hinaligue white, 5,681.8.

Miscellaneous tropical fruit trees.—The orchards of miscellaneous tropical trees are being cover-cropped with *Tephrosia candida, Calopogonium mucunoides,* and *Centrosema pubescens.* Vigna marina is also being tried as cover-crop. There are 2,098 trees consisting of 319 varieties left in the orchards after eliminating the undesirable ones. Besides a collection of 23 varieties of palms consisting of 163 plants is maintained.

There are two trees—caimito and lemasa—that flowered this year in the propagation orchard of the station besides the marcotted chicos and avocados. The caimito fruited but the lemasa failed to develop fruits.

Vegetative propagation tests.—From the trial budding or grafting experiments with different fruit trees and ipil-ipil the following results were obtained:

	Per cent
Chinese Litchi grafted on Alpay	14
Chinese Litchi budded on Alpay	33
Serali grafted on Bitungol	35
Serali budded on Bitungol	100
Lemasa budded on Nanca	25
Marang budded on Comihan	100
Marang grafted on Comihan	10
Rambutan grafted on Bulala	16
Caimito grafted on Caimitillo	77
Ipil-ipil grafted on Ipil-ipil	100

The trial grafting with ipil-ipil was done with the intention of producing seedless ipil-ipil plants later (by grafting seedless scion on seeded stock).

In addition to the success obtained in marcotting Rambutan, Chico, Caimito, Chinese Litchi, Wampi, Serali, Ciruela (Siniguelas), Longan, and Alpay the following were also successfully rooted this year: Camansi, Chesang, Damia, nut and Cefalus.

A comparative test of cover crops.—Planting of different cover crops introduced from foreign countries such as *Calopogonium muconoides*, *Centrosema pubescens*, *Tephrosia candida*, *Tephrosia hookeriana*, *Crotalaria usaramoensis*, *Indigofera* sp.; and native manimanihan and anipay (Palawan bean) produced good covering, but the manimanihan and anipay dried up during the hot season. The *Indigofera* sp. and *Tephrosia hookeriana* showed very poor development of foliage, even when planted thick.

Coöperative trial planting work with different crops.—Some of the following plants distributed in Pampanga Province have fruited: Citrus, caimito, avocado, hevi, serali, berba, kayam, biriba, Excelsa coffee, and Isabela grape.

In Bataan the following plants under coöperative trial planting are in good condition and some of these have fruited—avocado, coffee, caimito, pineapple, lemasa, tiessa, hevi, perunkila, serali and biriba. Forage grasses and sugar cane are also thriving.

RUBBER

Halcon Rubber Experiment Sub-station, Baco, Mindoro

Tapping intervals for Para rubber.—The fourth year's results (from December, 1928 to November, 1929, inclusive) showed that of the 12 tapping intervals with the use of the half spiral method in the morning, the 3-day interval gave the highest average daily yield—19.4 grams of dry rubber per tree—computed from the actual yield of 64.0822 kilos of dry rubber, obtained from 24 trees during the 139-day tapping period.

A comparative test of tapping with the half-spiral, V-shaped and oposite V-shaped methods.—Results from December, 1928 to November, 1929 show that by the V-shaped method, tapping on alternate days in the morning produced the highest—20.2 grams of dry rubber per tree a day—which result surpassed those of the two preceding years when the half-spiral tapped on alternate days and the opposite V-shaped methods gave the best results. The corresponding actual yield was 87.2151 kilos of dry rubber, obtained from 30 during the 144 tapping days.

A comparative test of ¼ and ⅓ spiral tapping at daily and alternate daily periods.—The ¼ spiral tapping on alternate days in the morning yielded the highest—11.9 grams of dry rubber per tree a day—calculated from the actual yield of 51.8355 kilos of dry rubber of 30 trees during the 144 tapping days. This excelled the highest yielder—the ⅓ spiral tapped daily—of the previous years.

A comparative production by 1-inch, 1¼-inch, 1½-inch, 1¾-inch and 2-inch monthly bark shaving.—As in the preceding year, the highest average daily yield was 10.9 grams of dry rubber per tree calculated from the actual yield of 32.1363 kilos of dry rubber obtained from 10 trees during the 293 tapping days by the half spiral method in the morning at the rate of 2 inches bark shaving a month.

A comparative production of tapping at 20°, 25°, 30°, 35°, 40°, and 45° angles.—Tapping daily in the morning at an angle of 45° gave the highest average daily yield—6.65 grams of dry rubber per tree. The actual yield of 19.5465 kilos of dry rubber was obtained from 10 trees during the 194 tapping days.

A comparative production by tapping (at 2 feet, 3 feet, and 4 feet from the base).—The 4-foot half spiral daily tapping in the morning outyielded the 2-foot which was the highest yielder of the preceding year—by giving an average daily yield of 5.7

grams of dry rubber per tree, followed in order by the 2-foot with 3.9 grams and 3-foot with 3.0 grams, respectively.

Fertilizer test with Para rubber.—The results from the second year's test with the use of ammonium sulphate were as follows: 1.5 kilos applied at 6-month intervals per tree yielded 9.8 grams of dry rubber per tree a day (highest); 2.0 kilos every 12 months, 7.5 grams; 0.5 kilo every 3 months, 7.2 grams; control trees, 6.3 grams; 1.0 kilo every 4 months, 5.9 grams.

Trees fertilized with guano at the rate of 2 kilos a tree once a year gave a higher yield—7.7 grams of dry rubber per tree a day—than the control trees which yielded 6.2 grams.

Distance of planting test.—The distances tried vary from 5 by 5 to 8 by 8 meters apart. In this experiment 540 Para rubber seedlings were set out over an area of 2.2196 hectares during the months of July and August, 1928. The trees were normally healthy and have an average height of 1.7 meters and 0.8 meter diameter of crown.

Lamao Experiment Station, Lamao, Bataan

Experimental budding of Para rubber.—Patch budding, 55 per cent success; shield budding with and without wood with the buds, 75 per cent and 0 per cent success, respectively. The dormant buds did not develop although they remained green for several months.

SEMI-TEMPERATE CROPS

Baguio Semi-temperate Fruit Experiment Station, Baguio, Mountain Province

Acclimatization test of semi-temperate fruit trees.—The following are under test at the Baguio Semi-temperate Fruit Experiment Station, Baguio, Mountain Province:

There are twelve varieties of apples planted of which the Rome Beauty exhibits the most vigorous growth. The Winesap, the Rome Beauty, and the Eastman apples have shown signs of fruiting. The naturalized Mountain apple has again fruited at the station. Of the three varieties of peaches planted none has fruited so far in Baguio. Of the four-year varieties, the Bartlett seems to be the most vigorous in growth. A variety of quince is doing fairly well, as is the Tanaka loquat. All the varieties of kaki are flourishing but none has so far fruited at Baguio, but in Sagada and Bauko, trees of an unnamed variety of kaki have yielded as much as 500 fruits per

tree. The two American persimmons have shown but little growth since their introduction. The Green Ischia fig has fruited for the second time. Of the 17 varieties of grapes, the Concord and Pierce are the most promising, the former having fruited for the first time this year. Of all the pecans tried none seem adapted to the Baguio soil and climatic conditions. Of the six varieties of cherries, two are still thriving. Five almond varieties are being tried but they do not seem to do well during the rainy season. The chestnut (S. P. I. 66037) from the United States Department of Agriculture shows the most vigorous growth out of the three varieties under cultivation. Of the four walnut varieties, the Paradox grown from a seedling plant is the most vigorous. The five varieties of olives planted at the station are all doing fairly well.

The Lychee has flowered in Baguio but failed to set fruits. Two types of plums, the Japanese and the European, representing 8 varieties, are under trial, but trees of the Japanese type are the most vigorous. The newly introduced varieties of gooseberries are growing but have not fruited yet. Of the varieties of strawberry, the Ecuador is the most vigorous.

Two varieties of blackberries collected locally are being raised.

Citrus and avocado fruits.—The lemons are all doing well, and the Lisbon variety has fruited for the first time. The King mandarin orange does not thrive there, on the other hand the Kishiu has fruited for the first time. The Chinese and the Siamese pummelos are making a good start. All of the nine orange varieties are doing first rate with the exception of the Majorca which is very badly attacked by scale insects. The Dugat and the Jaffa fruited last year.

Coffee and tea.—Five Arabian coffee varieties and strains from Porto Rico have been imported for trial planting in Baguio, and plants of Mocha coffee have already been set out in the permanent orchard and are now beginning to fruit. Several types were produced from the resulting plants of this variety. Both the Chinese tea and the tea from Java are flourishing.

Miscellaneous field crops.—Wheat planted for the third time in Baguio matured in 124 days and yielded 3.5 kilos from an area of 34 square meters of ground. The trial planting of the Storm Proof, Reemi Tardif, and Gopher rices failed at Baguio. The paspalum, carpet, red top, canary and crib forage grasses are growing nicely. The Kikuyu grass which has been successfully tried is now in great demand around Baguio.

Tephrosia candida has proved well adapted to Baguio, while the *Tephrosia hookeriana, Calopogonium mucunoides, Centrosema pubescens, Cassia floribunda, C. laevigata, Melilotus alba* and *Crotolarias* are still under observation.

The flax which was planted on a small scale for the third generation, showed fair growth and yield.

The bush cranberry introduced from the United State did well. The chick-peas proved a failure. Of the tomatoes cultivated none produced seeds because of wilt. The aralias are in good condition.

The chayote and the cyndra are being distributed on a large scale, and the former is now extensively grown in the vicinity of Baguio. The "smooth type" chayote produced 182 fruits per vine and the "rough kind" 190 fruits.

The Giant bamboo from Lanao is growing well.

SPECIAL FIELD INVESTIGATIONS

None of the olive trees planted in Bontoc and in the Bureau of Forestry Nursery in 1914 and 1915 have so far fruited.

The West Indian type of avocado has fruited well in the Mountain Provinces, while the acclimatization of both the Guatemalan and the Mexican types is still in progress.

Two peach trees in Baguio supposedly of Japanese origin have fruited during the year.

VEGETABLES

Lamao Experiment Station, Lamao, Bataan

Variety test.—In a variety test of cabbage consisting of 18 varieties received from Germany, the following gave the highest yields: Filder, 16,126.968 kilos per hectare; Zlaco, 13.777.764; Sweedish, 12,476.178; American, 12,126.972; Hartmonns' Earliest, 11,619.036; Ironhead, 10,063.482; Baby Savoy, 9,873.006; Danish Roundhead, 9, 777.768; Drumhead Savoy, 9,555.546; and Succession, 7,805.516.

Fertilizer tests.—In the fertilizer test of native tomatoes the plot fertilized with sodium nitrate (200 grams applied around each plant) gave the highest yield of 2,676.582 kilos per hectare; that with ammonium sulphate (applied as above) was second with 1,801.25 kilos; and the control the last with 656.065 kilos.

In the fertilizer test of eggplant (from which young fruits as vegetables were harvested) sodium nitrate applied at the rate

of 200 grams around each plant gave the highest yield of 15,832.83 kilos per hectare; and ammonium sulphate (applied as above) second with 14,390.869 kilos, as against 3,129.264 kilos of the check plot.

In the fertilizer test of pechay, the mixture of ammonium phosphate, superphosphate and bone meal at the rate of 66.66 grams each per hill applied around each plant yielded 27,199.788 kilos per hectare; the mixture of ammonium sulphate, superphosphate, an bone meal (at the same rate as in the above) gave 26,560.00 kilos; ammonium phosphate (alone) applied at the rate of 200 grams per plant yielded 24,654.453 kilos; and the mixture of sodium nitrate, superphosphate, and bone meal applied at the rate of 66.66 grams each per plant gave 23,918.176 kilos. The check (unfertilized) yielded 7,583.303 kilos per hectare.

FRUIT AND VEGETABLE PRESERVATION AND OTHER MISCELLANEOUS LABORATORY WORK

Banana figs.—In making these the same process as in making mango figs was followed (see under Mangoes).

Bunag and binukao.—Both of these fruits were made into excellent preserves like the mangosteen by entirely freeing the seeds from the pulp and then dropping them in boiling syrup till this becomes thick. They are then bottled and sterilized in a steam sterilizer with ten pounds pressure.

Chayote.—This fruit, now produced abundantly in and around Baguio is found to make a good sweet in the dry form and when preserved in syrup, besides being good both as a vegetable and a pickle. The prepared pieces are soaked overnight in lime water. The natural taste, however, is improved by soaking the pieces for a shorter time, say 30 minutes to an hour or till they become brittle, in strong lime water, then blanching them for a few minutes and allowing them to dry before placing them in boiling medium-thick syrup, over which is sprinkled a little dilute acetic acid and a few drops of spirits of lemon and anis. The dry sweet is made by further boiling the mixture till the syrup becomes very thick, then taking the pieces and dusting them with granulated sugar and then drying them perfectly in the sun. The sweet preserved in syrup is kept best by sterilizing the filled jar in a steam sterilizer with 15 pounds pressure.

Culiat.—Culiat (bulso) was prepared in many forms as follows: Boiled: by dipping the fruits in boiling water till the husks become soft, and then carefully removing them from the nuts. If this is not done, they may produce a stinging pain in the throat.

Fried: By peeling off the fresh husk of the kernel, then slicing thin and frying.

Sweetened: By removing the husk of the boiled nut, then slicing thin and putting into thick syrup.

Cashew nuts.—Cashew nut butter has been found to have a better flavor than peanut butter. The method of preparation is similar to that used for making peanut butter except as to the shelling and roasting. When cashew nuts are shelled, care must be taken not to allow the turpentine of the skin to come in contact with the kernel, as it is very irritating to the palate. The shelled nuts are roasted immediately in an oven over a slow fire and then ground as in making peanut butter.

Durian.—This fruit made a good ice cream giving—flavor similar to sugar apple ice cream.

Hevi.—Peeled fruits were made into jam, jelly and paste as follows:

Jam: By boiling the peeled and sliced pulp till tender, then passing it through the sieve to remove the fibers. A cup of sugar to every cup of the fruit is then added and the mixture boiled till thick.

Jelly: By boiling the peeled and sliced green fruit till soft, filtering while hot, and for every cup of the juice adding 2–3 tablespoonfuls of apple juice and 1 cup of sugar, then boiling to a jelly consistency. A little lemon also improves the flavor to some tastes.

Paste: By boiling the jam further to the consistency of a paste. The addition of one-half a cup of milk to a cup of the jam before boiling it will improve the taste of the paste.

Mangoes.—Fruits of mango were made into mango-figs. In this case two processes proved to be good: coating and not coating with granulated sugar. The fruits which were coated with granulated sugar were first sliced and half-dried before being dusted with the granulated sugar finally dried completely; while the other fruits after being sliced were completely dried at once. The granulated sugar-coated mango fig retained the flavor better than the other kind.

Mango fruit storage experiment.—The following are the results of the experiment conducted during the year:

Number of fruits	Condition of fruits	Treatment	Results
200.......	Beginning to ripen...	In basket and then placed near ice (about 0 ° C)	After 40 days 15 per cent of the fruits partly decayed; 38 per cent showed signs of rot but the flesh as still good to eat; and 47 per cent apparently in good condition. The 47 per cent after 3 days' exposure to ordinary room temperature all showed signs of rotting.
200.......	Fully developed (bud not ripening yet).	Same as above ..	After 40 days 20 per cent of the fruits partly decayed; 30 per cent showed signs of rotting but flesh was still good to eat; and 50 per cent apparently in good condition. The 50 per cent after exposure to ordinary room temperature all showed signs of rotting.

Sun drying of mango fruits.—After the ripe mango fruits have been peeled, they were dried in the sun for 2 days and then stored for a year or so in air-tight containers. To hasten the drying, however, a knife blade was passed through the middle of each but not cutting it entirely (into halves). After the drying about 78 per cent of the weight was lost. It was found that fruits treated as above could still be made into sweet or candy.

Papaya.—The green papaya fruit when made into dried sweet excels in taste the kind preserved in syrup and it is prepared as follows:

The fruits, cut into pieces, are soaked overnight in lime water, then blanched for a few minutes and the water drained off before they are put into a boiling, medium-thick syrup. They are allowed to remain in this syrup overnight, and the next day boiled again till the syrup becomes very thick. Then the syrup is drained off and the fruits washed with clean water in as short a time as possible just long enough to remove the sugar from the outside surfaces and then perfectly dried in the oven. The addition of a little ground grain of anis during the preparation improves the flavor.

Peanut butter.—Peanuts beside being used in candy and roasted or salted, were also made into butter, as follows:

The shelled peanuts were first soaked in water before being roasted and while still hot ground so as to extract their oil contents better.

Pineapples and lemasa.—These fruits were both made into good preserves with syrup. When candied, they are more delicious. The candied fruits were prepared by putting the sliced

pieces into medium thick syrup made of commercial glucouse and sugar and boiling for a few minutes till a little bit thick and then allowed to remain in the syrup overnight. Then they are again boiled for five minutes every day for three or four days, and on the last day, boiled till very thick. Lastly the syrup is taken off and the slices dried in an slow-fire oven or in the sun. The product is still further improved by dusting it with granulated sugar and drying as before. Candied fruits treated in this way are more pliable and delicious.

Rimas mold.—A certain mold from the Rimas was obtained from over-ripe rimas fruits. The fruits were peeled and cut into small pieces. To every cupful of the pulp just prepared, one-third of a cup of five per cent dilute acetic acid and one-fifth of a cup of sugar were added and the material placed in clean bottles. The containers were then covered with thick cheese cloth and put in a dark place at ordinary room temperature. For about two months or more, rimas mold was produced. Then the mold was taken out of the bottles, washed well, soaked overnight in rice washings and placed in warm water till white. Next it was divided into pieces of the desired size, put in medium-thick syrup and boiled till cooked. Rimas mold made into sweet, has a good taste although not as good as pineapple mold.

Rice "pinipig".—Pinipig made of rice which has been stored for a year in air-tight containers produced grains which were found hard in texture while the flavor was not altered.

Rice and corn.—Many different varieties of rice and corn were tested for their popping qualities and among the tested varieties, the "Kabuto" rice proved the best, having 86 per cent popping, 1 per cent semi-popping, and 13 per cent not popping. Of the three tested varieties of flint corn; red, yellow and white, the yellow variety proved the best, having 79 per cent popping, 21 per cent semi-popping and 10 per cent not popping, after two weeks drying in the sun.

In one experiment, a glutinous corn was used to mix with the ordinary rice in cooking. One part of the glutinous "corn-rice" (hominy) when mixed with one part of the ordinary rice and cooked made a more palatable food than a mixture of the ordinary rice and "corn-rice" of the flinty varieties.

Serali and other fruits.—Simple dehydration of Serali fruits made them very hard in texture and practically devoid of taste. However, it was found that they are better prepared by blanch-

ing them in thin boiling syrup for a few minutes and then partly drying them. With both green and ripe papayas, rimas and green bananas, the same was done with similar results.

Root crops.—Sweet potatoes, cassava, tugui, ubi, etc., first perfectly dried in the sun and then stored as such for quite a long time—6 months in this case—can still be utilized for food purposes. Some retain their fresh flavor. Others can be converted into flour.

Miscellaneous work.—Many different kinds of fruits—both native and introduced—as well as different varieties of sugar cane and vegetables have been preserved in their natural color, for museum purposes. The different chemicals tried at first were copper sulphate, acetic acid, sulphurous acid, alcohol, formalin, sulphur dioxide gas, boric acid, etc., but the following chemicals have been proved good:

(1) For yellow, white and certain red-colored fruits and vegetables, sulphur dioxide gas passed through distilled water was used.

(2) For green-colored fruits and vegetables, there was previous treatment with copper sulphate solution for 1–3 days, and then sulphur dioxide gas passed through distilled water as the final preserving solution.

(3) For red-colored fruits and vegetables, different percentages of formalin and boric acid solutions added to sulphur dioxide solution were used. This last process is still under observation, however.

The tensile strength of 2,000 or more samples (excluding the duplicates) of abacá, maguey, and sisal fibers, was determined.

Herbarium specimens of fruit crops, weeds, cereals, coffee, tobacco, etc., were dried and mounted.

SEED AND PLANT DISTRIBUTION AND INTRODUCTION

Various kinds of seeds and plant materials were raised by the different agricultural experiment stations of the Division during the year 1929 for free distribution for coöperative trial planting, for foreign exchange and for sale direct by the stations concerned or through the Agricultural Extension Division of this Bureau with a total estimated value of ₱33,344.92.

This division introduced from foreign countries during the year 59 species of plants, consisting of 60 varieties of different fruit trees, vegetables and field crops for experimental planting in this country on a small scale.

AGRICULTURAL EXTENSION DIVISION

The division extended its field to Oriental Negros and Samar. It coöperated with local officials and the Red Cross in food production and rehabilitation work in the typhoon- and flood-ravaged areas.

HORTICULTURAL CAMPAIGN

There were 439,531 fruit trees planted during the year where the agents are assigned.

The demand for seedlings having increased beyond the limited supply, especially of coffee, in the Lipa Station, the commercial nursery men of Batangas supplied a number of farmers of Tayabas, Laguna, Cavite, Mindoro and the Bicol region thousands of coffee seedlings and seeds; and with 69,200 citrus seedlings and 2 gantas of seeds and 7,500 miscellaneous seedlings of fruit trees.

In the districts covered by the agents and nurseries there were grafted: 1,680 citrus, 4,075 budded citrus and 610 other plants. Other grafted plants were 6,693 mango, 324 lanzon, and 890 other plants; marcotted: 443 chicos, 231 citrus, 24 lanzones, and 285 other plants; pruned: 6,658 coffee, 3,214 citrus, 1,921 cacao, and 12,221 other fruit trees.

The fruit trees propagated in the nurseries by the fruit growers were as follows: Coffee. 225,635; kapok, 12,200; mango, 1,755; citrus (grafted), 150; citrus (seedlings), 15,557; avocado, 15; coconut, 27,020; lanzon, 5,034; nangca, 540; cacao, 36,055; rimas, 380; papaya, 970; miscellaneous, 6,705. These plants are being planted as fast as ready.

Distribution is made through the Central Office and at the three insular nurseries, in Singalong, Manila; Lipa, Batangas; and La Paz, Iloilo. Some materials, such as budded citrus, sugar cane, coffee, and some field crop seeds were furnished by the Division of Experiment Stations.

The total value of the seed and plant materials distributed was ₱37,996.90, besides ₱8,198.47 worth of materials furnished free to typhoon and flood sufferers by the Red Cross.

The economic plants propagated were as follows:

	Distributed	Undistributed
Fruit tree seedlings	101,763	109,383
Hawaiian pineapple	41,187	397
Para rubber	3,537	6,626

Singalong Demonstration and Propagation Station.—Mushroom culture was this year started at the station in two small

beds (one—2 x 6.5 meters and the other 1.5 x 8.5 meters). producing from October 8 to November 30, 1929, 352 mushrooms weighing 11.41 kilos and 529 or 12.7 kilos respectively. The materials used were rice straw, stable manure, broken rice ("binlid"), sprayed with salt water.

Lipa Demonstration and Propagation Station.—The plant materials distributed and undistributed during the year were as follows: distributed: (sold), 63,560, valued at ₱1,677.60; (free), 28,327, valued at ₱1,146.90. Undistributed: 144,291, valued at ₱5,074.21.

La Paz Demonstration and Propagation Station.—This station is also propagating sugar cane and other field crops besides different fruit trees. The plants propagated are as follows: Distributed (sold) 17,646, value, ₱2,578.85; (free) 2,069, value, ₱388.40; undistributed: 26,340, value, ₱2,152.90.

Seed materials distributed were 36 packets and 90 kilos (sold), value, ₱281.60; (free), 27 kilos, value, ₱43; and also 5,500 ears of corn, 16 sacks of peanuts and 83,200 cuttings of sugar cane were sold for ₱862.00; and 1,040 ears of corn, 1 sack of peanut and 32,500 cuttings of sugar cane, valued at ₱293.90 were distributed free.

Provincial nurseries.—There are now 20 provinces that have provincial nurseries. Occidental Negros is the latest established during the year.

Producers' associations.—The activities in this line were mainly educational and advisory and efforts were made to keep in operation those already organized. Little progress was attained, as the great mass of the farmers are indifferent, through lack of local leadership. It is planned to encourage and back the organization of associations among coconut and citrus growers in the near future when the services of personnel from the Central Office can be spared.

The associations in operation are the:

1. Nemmatan Tobacco Producers' Association, Nemmatan, Jones, Isabela.
2. Echague Tobacco Growers' Association, Echague, Isabela. It has 485 members which sold coöperatively 5,000 quintals of Echague tobacco to "Helena & Company."
3. Masaraga Coöperative Marketing Association, Oas, Albay.
4. Mauraro Coöperative Marketing Association, Guinobatan, Albay.
5. Livestock Coöperative Marketing Association, Guinobatan, Albay.
6. Mayon Coöperative Marketing Association, Tabaco, Albay.

Vegetable growing.—Farmers are helped to secure and store seeds, eradicate pests and diseases and adopt proper methods of culture and soil improvement.

Vegetable seeds and seedlings are raised in some nurseries to be distributed to farmers from time to time.

Poultry work.—Selection of fowls, proper management, feeds and feeding, caponizing and treatment of diseases are given due attention.

A total of 3,156 chickens were caponized and 1,343 treated for various diseases, as part of the demonstration work. There were 219 animals castrated.

Rice work.—As in previous years, the planting of the best Bureau rice varieties in different districts of the Islands, particularly in the large rice producing provinces, to effect increase of production of the crop received considerable attention from the division. Of the different varieties planted, Ramai proved superior, especially in the Provinces of Tarlac and Bulacan, on account of its hardiness and heavy yield. This variety is now being commercially grown. Khao Bai Sri, Apostol, and Sipot have generally proved to be high-yielders. In quality, Khao Bai Sri is considered A-1. For dry season crop, Sipot is unequalled, while Apostol has proved to be one of the best medium early varieties. Improved seeds were in great demand among the farmers. The Bureau distributed 395.15 cavans, mostly of Ramai, Khao Bai Sri, Sipot, Apostol, and Inantipolo. Also 9 cavans of other varieties, including Elon-elon, Mancasar, Kinastila and Binacroy, were distributed in small quantities in places where they had not been tried for coöperative trial planting.

An extension agent was assigned in Samar where there are extensive areas suitable for rice growing, 6 Luzon Lagio plows and two harrows are used for demonstration. There the local method of preparing rice land is the "payatak" system which is probably the cause of low unit production in that region. For trial planting, 4 cavans of Ramai and 6 cavans of Apostol were distributed along the western coast towns of Samar.

In the Province of Surigao where the method of planting rice is similar to that in Samar, the rice growers are also urged to use the plow and harrow in preparing their paddies and to build proper dikes to accumulate sufficient water for the rice plants.

Tobacco project.—For the improvement of the tobacco industry in the Cagayan Valley, the Agricultural Extension Division has seven agricultural assistants—three in Cagayan and four in Isabela. To raise the quality of tobacco and to correct defective curing methods now prevailing (under houses and in houses), five model curing sheds were constructed during the early part of the year in centrally located points in the valley—three in Isabela and two in Cagayan. A caretaker is assigned to each shed. Toward the end of the year another shed for Isabela and one for Cagayan were constructed.

The campaign for the planting of wrapper tobacco varieties has always been given much emphasis. These varieties are widely distributed now. But the flood during November, 1928, reduced greatly the production for 1929. The growers in Cagayan that succeeded computed the yield per hectare at 7.5 to 12 quintals, mostly Philippine-Sumatra and Florida-Sumatra.

In the 1929–30 tobacco season, 26 kilos of seed were distributed, besides 89,665 seedlings and 26.9 kilos of seed selected by the different farmers from their last crop. It will be noted that less seed was distributed during the year as many farmers raised their own and the agricultural assistants have each maintained seedbeds in the lots attached to the curing sheds. These seedlings, mostly of Vizcaya, Philippine- and Florida-Sumatra are for distribution to the farmers. Better seedlings are of course produced in this way.

The following shows the number of model tobacco curing sheds, locations and quantity of tobacco leaves cured therein during 1929:

	Number of palillos cured
1. Baculod, Amulung, Cagayan	1,297
2. Ugac, Tuguegarao, Cagayan	1,289
3. Nagbayugan, Piat, Cagayan	....
4. Allinguigan, Ilagan, Isabela	2,603
5. Palattao, Naguilian, Isabela	3,359
6. Casibarag, Cabagan, Isabela	1,036
7. Dugayong, Echague, Isabela	....
Total	9,584

For the purpose of minimizing the damage caused by tobacco cutworms in the field, the use of calcium arsenate powder has been introduced. Over 84 kilos were used for this purpose and distributed to the people, and 60 kilos were purchased by individuals.

In connection with the tobacco campaign, the farmers are being induced to plant permanent crops. As a result, there were planted in the valley during the year, 57,550 different fruit trees, mostly cacao and coffee, besides over 50,000 seedlings raised in the different private nurseries.

Sugar cane.—The work consists in helping farmers to secure desirable varieties of sugar cane suitable to the locality from different sources. The agents supervised the fields of some co-operators who had been furnished by the Division of Plant Investigations with small lots of sugar-cane cuttings from time to time. Especially to small farmers and in provinces where this crop is not extensively cultivated, the agents are teaching the best cultural methods. Cagayan and Isabela, both tobacco growing provinces, are now planting sugar cane for centrals are now under construction in Gattaran, Cagayan, and in Tumauini, Isabela.

The Central Office has distributed through La Paz Demonstration Station 43,560 cuttings and 66,220 cuttings of sugar cane, mostly Negros Purple, Badila, H–109, New Guinea 24–A and 24–B and P. O. J. 2878.

Abacá project.—For the purpose of improving fiber production, the division has employed under Act 3263, 7 educational fiber inspectors, assigned in fiber producing provinces; namely, Sorsogon, Albay, Camarines Sur, Camarines Norte, Leyte, Samar, and Cebu.

The work of these inspectors is to induce the rejuvenation of old abacá and maguey plantations, to disseminate improved cultural methods and to classify fibers for better prices. Benito knives as well as a few Heath knives have been loaned to the growers for stripping to improve the quality of fibers. To discourage the practice of including abacá stalks in stripping, which lowers the quality of the fiber, a campaign for adopting a model ordinance on the matter was made in Samar Educational Fiber Inspectors Flores and Frencillo. This will be done in all other abacá provinces where there is no similar ordinance.

These fiber inspectors visit different plantations to observe the best cultural methods employed, the variety grown, and all practices and phases of the local industry, and to give farmers in other sections information on all improvements found which are applicable to their local conditions.

The suckers of abacá introduced in Cagayan a few years ago are gradually increasing, indicating that this fiber plant will succeed in some sections of that province.

Seed farms.—Under Acts 3443 and 3527, seed farms are being developed as distributing centers where good seeds of desirable varieties of crops can be produced and made available to the farmers.

The greatest handicap to the immediate prosecution of the work has been the lack of public land adequate for the purposes of seed farms, so it became necessary to use private lands to start the work during 1929. The plan of development for seed farms calls for a station in each of the following provinces:

Provinces	Special crops
1. Occidental Negros	Sugar cane, coffee, and corn
2. Nueva Ecija	Rice
3. Pampanga	Sugar cane and rice
4. Cebu	Corn and sugar cane
5. Lanao	Coffee and coconuts
6. Samar	Rice and corn
7. Leyte	Rice and corn
8. Isabela	Corn and rice
9. Bicol Peninsula	Rice and corn

The seed farms project in Malolos, Bulacan, operated on leased private land, was undertaken pending the establishment of the one for Nueva Ecija.

The operation of the Malolos seed farm has so far been successful. The farm practices, the crops grown, and the irrigation methods have been object lessons to the farmers in the vicinity. The rice crop may be all cut during the second week of January and threshed by February 15, 1930. Complete records will be made in the 1930 report.

Only a start has been made in La Carlota, Occidental Negros, but 1930 wil see the seed farm activities in the station in full operation. Actual work on getting land for the seed farm project did not begin till after April, 1929.

Investigations and reports were submitted for seed farms in Pampanga, Nueva Ecija, Samar, and Lanao, and only official approval is pending before actual field operations can be undertaken.

Dynamiting work.—The use of dynamite has been popularized in view of the keen interest in fruit-tree planting in the suburbs of Manila and for this work the services of one extension agent have been constantly utilized.

During the year, 1,351 holes were blasted at a total cost of ₱1,107.74 for dynamite, caps, and fuses, at about ₱0.82 a hole.

It may be noted that using dynamite is rather expensive as compared with hand labor, and in establishing large plantations or commercial orchards its use may appear prohibitive. But the benefits derived therefrom more than repay the expenses incurred.

PLANT PESTS CONTROL DIVISION

Administrative Orders No. 34 and 52 were revised. An administrative order governing the introduction into this country of coffee plants or parts thereof, berries and seeds was also prepared.

LOCUST CAMPAIGN

During the first eight months the whole Archipelago was kept free from the pest. No report of infestation was received from the end of the month of August to the close of the year.

The following shows the comparative data of infestation for the years 1928 and 1929:

	1928	1929
Provinces infested	13	9
Provinces freed	8	9
Provinces still infested at the close of the year	5	0
Municipalities infested	167	60
Municipalities freed	158	60
Municipalities still infested at the close of the year	9	0

During the year there were destroyed in the populated districts (general campaign) 14 gantas of locust eggs; 3,156 cavanes and 3.5 gantas of hoppers; 4,234 cavanes and 11 gantas of flyers. 12–25–28 hectares of rice and 1/15 hectare of corn were damaged.

In the general scouting work, of the 54 municipalities and 3,453 sitios inspected, 18 municipalities and 462 sitios were infested. Of the 536,051 hectares of land in isolated places inspected, 1,416⅛ hectares were found to be infested. One cavan and 13⅜ gantas of eggs, 3,039 cavanes and 15 gantas of hoppers and 728 cavanes and 70 gantas of flyers were caught and destroyed.

LOCUST SCOUTING

(Act No. 3163)

Scouting operations were conducted in six provinces, but were more extensive in the Provinces of Cagayan, Isabela, the Mountain Province, and Nueva Vizcaya, these being permanent sources of infestations in northern Luzon.

A total area of approximately 111,000 hectares was scouted in Cagayan, Isabela, and Nueva Vizcaya. There being no infestation anywhere scouting flights by aeroplanes were stopped about the middle of December, 1929.

CONTROL OF COCONUT PESTS AND DISEASES

In view of the necessity of continuing the campaign in the provinces additional allotments making a total of ₱26,000 were given to the various provinces for this work alone. Funds were also allotted to the Provinces of Camarines Norte, Davao, Leyte, and Sorsogon.

The regular campaign in the Provinces of Batangas, Laguna, and Tayabas was interrupted in October due to the extraordinary infestation by the coconut leaf miner beetle, *Promecotheca cumingi* Baly, to combat which the whole force in each province together with the other personnel of the division as well as the field men of the Agricultural Extension Division, provincial and municipal officials and planters themselves in the three provinces, had to be detailed.

A total of 14,883,263 coconut trees were inspected, of which 41,537 were found attacked by bud-rot. Of this number 25,387 trees were destroyed. Nine hundred and seventy-nine of the 8,977 trees found affected with stem bleeding disease were destroyed and 7,141 treated. Of the 13,921 trees infested with red beetles, 2,749 were destroyed and 9,991 treated. And of the 26,611 infested with black beetles, 3,631 were destroyed and 14,644 treated.

Bud-rot infection has been found to be most serious in Sorsogon. This is due to the fact that the campaign in this province has only been newly organized and the bud-rot infected trees have not been cut down. The infection in Albay is also high but the campaign has been extended to the municipalities where such work was not done formerly. The infection in Cavite is also high probably due to the weather conditions favorable to the development of the disease in regions which can not be continuously inspected. The red beetle was bad in Lanao and the black beetle in Mindoro and Palawan.

PLANT PESTS SECTION

Most of the time and efforts of the entomology section were again taken up by a large number of complaints and inquiries, about 350 or more in all, from different parts of the Islands.

Inspectors were sent whenever possible to help the parties concerned control the trouble.

SUGAR-CANE INSECTS

Sugar-cane grubs.—The root grubs found in destructive numbers were those of *Leucopholis irrorata.* The posters and circulars on this insect distributed by this Bureau were found to be of great help in the campaign as they had been in Batangas.

Reports of serious destruction by grubs to sugar cane in Negros Occidental were received during October, 1929.

Planters were advised to clean such fields of grubs and practice crop rotation or replant or "lusoc" it. They were further told that before plowing the land the stumps should be pulled out to expose the grubs, since most of them are found among the roots.

Coconut insects.—One of the worst outbreaks in years was that of the coconut leaf miner *Promecotheca cumingi* Baly. Extensive areas were infested in Laguna, especially in San Pablo, Calauan, Rizal, and Alaminos. Because of the demand for actual help by the coconut planters and other parties concerned after the infestation had become widespread practically all the personnel of the section, including other technical men, were sent to Laguna to show the planters how to control the pest and to help organize a campaign to prevent further spread.

IMPORTATION, BREEDING, AND LIBERATION OF BENEFICIAL INSECTS

On February 7, 1929, two larvae of the parasitic wasp, *Encarsis flavoscutellum* Zehnter, consigned to Dr. L. B. Uichanco, of the Department of Entomology, College of Agriculture, University of the Philippines, Agricultural College, Laguna, arrived from Formosa. The insect is a parasite of the sugar-cane louse, *Oregma lanigera* Zehnter. They were taken direct to Los Baños for breeding under Doctor Uichangco's management. The breeding of the lady-bird beetle (*Cryptolaemus montrouzieri*) imported by Mr. H. A. Lee of the Philippine Sugar Association from Hawaii in 1928, was attended to in the laboratory.

PLANT DISEASES SECTION

Coconut bud-rot investigations.—Isolation of the causal organism of bud-rot preliminary to morphological, cultural and physiological studies of the organism, and to inoculation work was effected.

Sugar-cane disease investigation.—Studies on the nature and cause of the wilt or sugar-cane seedlings, which is prevalent in nurseries at Canlubang, Laguna and Del Carmen, Pampanga, and the methods of controlling it were made; and also studies on the Fiji disease in relation to soil alkalinity and on mosaic and "Negros Yellows."

The results of the experiments started by Mr. F. B. Serrano, formerly of this Bureau, on abacá variety-resistance tests to the heart-rot and bunchy-top diseases have shown that while some are extremely susceptible, there are others that are quite tolerant. Among the latter are the Irom, Jolo, Alman, Inorang, Sinamoro-puti, Libutanay, Punucan, Lagurhuan-Burawen, Lagurhuan-Dagame, Liahon, Tañgoñgon, and Maguindanao varieties.

PLANT QUARANTINE SERVICE

Inspection of plant materials.—There was a great increase in the number of parcels of plant materials inspected for 1929, there being 170,331 parcels more than those of 1928 alone.

Port inspection.—During the year, 1,365 vessels were boarded and inspected at the different ports of entry and 80,921 pieces of baggage inspected.

Pathological and entomological interceptions.—There were intercepted 13 pathological and 7 entomological specimens from the United States; 17 pathological and 6 entomological specimens from China; 3 pathological and 1 entomological specimens from Singapore; 1 pathological and 1 entomological specimens from Syria; 1 pathological and 5 entomological specimens from Java; 4 pathological and 2 entomological specimens from Japan; 1 pathological from Germany; 2 Pathological from Guam; 2 pathological from Sumatra; 1 pathological and 3 entomological from Cuba; 1 pathological and 1 entomological from Borneo; 1 entomological from Hawaii; 1 entomological from Spain; 1 entomological from Ceylon.

Parcels certified and exported to different countries.—A total of 403 parcels were certified and exported to different countries.

RURAL CREDIT DIVISION

In spite of the defects in the present law and the inability of this Bureau to secure new legislation, the Rural Credit Division continued its established policy of encouraging the associations leading to the establishment of a central bank in each province.

Inspection and supervision.—The whole Archipelago was divided into 11 districts. Each of these districts has a resident agent whose duty is to inspect each association under his supervision at least two or three times a year, except District No. 11, composed of the Provinces of Palawan, Zamboanga, Lanao, Cotabato, Davao, and Sulu, which has no resident agent because of lack of personnel; but the associations in these provinces are visited at least once a year by a man from the central office.

Association reincorporated.—Having completely paid up the capital stock for which it was incorporated, the Agricultural Credit Coöperative Association of Batac, Ilocos Norte, was reincorporated on February 21, 1929, with a capital of ₱10,000.

New associations.—During the year 1929, new associations were organized in the following municipalities:

Barugo, Leyte, incorporated February 1, 1929.
Sibonga, Cebu, incorporated May 20, 1929.
Manjuyod, Oriental Negros, incorporated June 22, 1929.
Ayuñgon, Oriental Negros, incorporated September 9, 1929.

No association was dissolved during the year 1929.

COLLECTION OF OVERDUE LOANS

Because of the urging of this office and our agents the majority of the long overdue loans were recovered during the year 1929. Court action, however, had to be resorted to against some delinquent borrowers, who, without reasonable excuse, failed to settle their long standing accounts when asked to do so, but many of them paid what they owned rather than be taken into court.

RICE AND CORN FUND

The supervision of the Rice and Corn Fund has been under the Rural Credit Division since the middle part of December 1929, when the special agent was detailed on special duty by the Secretary of the Department of Agriculture and Natural Resources.

At the close of business hours on December 31, 1929, the total loans granted to the different Agricultural Credit Coöperative Associations amounted to ₱30,000—₱140,402.28 had been received as repayments on loans and ₱44,104.55 as interest. On the same date there were assets in the amount of ₱1,425,258.26, consisting of: Furniture and equipment, ₱2,465.89; Cash, In-

sular Treasurer, ₱860,636.69; Loans Receivable, ₱562,142.59; and Supplies and Materials in stock, ₱13.09. After deducting the liability of ₱1,646.73 for accrued leave payable, the total assets will be ₱1,423,611.53.

The original appropriation was ₱1,000,000. There is then an evident gain of more than ₱400,000 after ten years operation. And even if the ₱200,000 to be transferred to the Seed Farm Fund, and Stock Herbs and Farms Fund by virtue of Acts Nos. 3624 and 3632, respectively, is deducted from the funds in the Insular Treasury, there will be ₱660,636.60 available for loans.

GENERAL PROGRESS

The following statement shows the financial condition of the 550 associations at the beginning of the year and that of the previous year. At the time of writing this report, complete returns from all the treasurers as of December 31, 1929, had not yet been received.

	1927	1928
Members	89,082	90,843
Borrowers	30,001	30,285
Depositors	2,207	2,198
ASSETS		
Cash on hand	₱118,630.61	₱135,597.52
Loans to members	2,595,619.78	2,585,873.64
Inventory	9,367.07	5,475.19
Other items	10,236.74	12,636.74
Total assets	2,733,854.20	2,737,583.09
LIABILITIES		
Capital stock	₱952,106.00	₱962,761.00
Regular deposits	66,809.93	60,449.70
Rice and Corn Fund	757,710.16	675,332.02
Special deposits	16,774.91	19,034.68
Interest collected	796,463.58	856,287.24
Entrance fees paid	22,181.67	20,411.49
Undistributed dividends	56,114.32	66,330.66
Reserve funds	63,826.09	75,752.25
Other items	1,867.54	1,224.05
Total liabilities	2,733,854.20	2,737,583.09

The decrease of ₱9,746.14 in loans shows that these associations made some notable collections of accounts during 1928, considering the fact that while the collecting was going on loans were also being granted at the same time to the needy members.

The decrease of ₱82,378.14 in loans from the Rice and Corn Fund shows that the associations were able to settle their debts or paid the instalment payments due on them because of the payments made by the borrowers of the latters' loans from the associations.

The decrease of ₱6,360.23 in regular deposits means that the associations have repaid many deposits made five years ago that fell due during the year 1928.

The decrease in the entrance fees is due to the compensations given by the associations, in the form of bonuses, to their secretaries for their services, and payments for general expenditures. No payments of bonuses, however, were approved by this Office unless the financial condition of the association concerned made such justifiable.

Increases may be however noted in:

Shareholders	1,761
Capital stock	₱10,155.00
Interest collected	59,823.66
Undistributed dividends	10,216.34
Reserve fund	11,926.16

VETERINARY SECTION

ADMINISTRATION

Importation from foreign ports.—During the year there arrived at the port of Manila, 8,609 cattle from Australia and 1,087 cattle from Pnom Penh, French Indo-China. No carabaos from foreign ports were received at Manila during the year. However, 1,158 carabaos and 175 cattle from French Indo-China were landed at Iloilo. Forty-eight head of the cattle were shipped from Iloilo to Manila and are included in the figures for Manila. A total of 7,907 cattle and no carabaos were imported into the Philippine Islands during 1928.

Interisland shipments.—There arrived at Manila from interisland ports 19,183 cattle and 3,321 carabaos, an increase of 2,700 cattle and 676 carabaos over the preceding year.

Inspection for which fees were collected.—A total of 174,635 animals of all kinds were inspected upon arrival at Manila, for which fees amounting to ₱22,603.10 were charged and collected. Of these animals 139,897 were swine.

Postmortem inspection in Pandacan matadero.—During the year 699 Pnom Penh cattle were slaughtered at this matadero, of which 5 were condemned and 694 passed for food.

Postmortem inspection in Azcarraga matadero.—There were 154,477 animals of all kinds inspected of which 152,553 were passed for food and 1,924 condemned. The number inspected includes 133,011 swine.

Postmortem inspection in Sisiman matadero.—At Sisiman 8,378 Australian cattle were slaughtered of which 56 were condemned and 8,322 passed for food.

COMBATING OF ANIMAL DISEASES

Rinderpest.—During the year 4,059 cases of rinderpest were reported with 3,105 deaths from this disease, an increase of 409 cases and 413 deaths over the previous year. The provinces in which the disease was present during some part of the year were Antique, Cagayan, Iloilo, Isabela, Laguna, Mountain, Nueva Ecija, Nueva Vizcaya, Occidental Negros, Oriental Negros, and Tarlac.

At the beginning of the year there were 13 infected towns in 6 provinces and on December 31, 1929, there were 12 infected municipalities in 3 provinces. There were 71 outbreaks of rinderpest during the year, counting each time a municipality was taken up as infected or reinfected as a separate outbreak.

The following table gives the number of rinderpest cases and deaths by three-month periods during 1929:

Rinderpest cases and deaths by quarters

Periods	New cases	Deaths
First quarter	1,492	944
Second quarter	934	746
Third quarter	862	743
Fourth quarter	771	672
Total	4,059	3,105

The slight increase of cases and deaths this year was due to an increase of activities in the Cagayan Valley and not to any general outbreak of the disease in any of the infected provinces. As in the previous years, ever since the use of rinderpest vaccine on a large scale, the disease has been held in check and general outbreaks aborted. It has been confined to mountainous and sparsely settled territories. In well or fairly well settled territory animals are usually under control and can be mustered for vaccination without much difficulty; whereas in the mountainous places, and in the vast unfenced plains in the Cagayan Valley

and elsewhere the rounding up of herds is exceedingly difficult. This is further aggravated by the fact that transportation facilities in such places are practically nil, and the people are rather backward and hard to convince of the benefits of vaccinations and quarantine measures. In those places progress in the control of disease will necessarily have to go slowly, unless the present appropriation for disease control work is very much increased for a number of years.

Anthrax.—Sporadic cases of anthrax were reported during the year from Bataan, Bulacan, Cavite, Laguna, Mountain, Nueva Ecija, Pampanga, Pangasinan, Rizal, and Tarlac. The number of cases and deaths were as follows:

	Cases	Deaths
Carabaos	468	431
Cattle	36	36
Horses	2	2
Total	506	469

These figures compared with those for the cases and deaths last year show an increase of 193 cases and 182 deaths. A total of 64,173 carabaos and cattle were injected with anthrax vaccine and anti-anthrax serum as against 62,480 carabaos and cattle injected the preceding year.

Hemorrhagic septicemia.—Outbreaks of this disease occurred during the year in Abra, Bohol, Laguna, Leyte, Mindoro, Misamis, Mountain, Occidental Negros, Pangasinan, Samar, and Sorsogon, with a total number of 577 cases and 545 deaths. The cases and deaths recorded the preceding year were 404 and 341, respectively. Leyte and Sorsogon were the provinces that suffered most from this malady, with 169 cases and 168 deaths and 115 cases and 96 deaths, respectively. A total of 7,652 animals—7,268 carabaos, 242 cattle, and 142 hogs were given hemorrhagic septicemia aggressin. The increase reported in the number of deaths from hemorrhagic septicemia during the year was apparently due to more systematic investigation an inspection.

Rabies.—No outbreak of this disease in large cattle was reported during the year.

Surra.—Four hundred nineteen cases and 399 deaths from this disease among carabaos, cattle and horses were registered during the year in the Provinces of La Union, Leyte, Mountain, Occidental Negros, Pampanga, Pangasinan, Sorsogon and Tarlac. The highest fatality was recorded among the horses of the

U. S. Army in Fort Stotsenburg, Pampanga, when surra broke out there on September 20, 1929. Three hundred and sixteen animals mostly mules, were destroyed.

Foot-and-mouth disease.—The total number of 496 cases and 102 deaths from this disease were recorded during the year from three provinces only; namely, Bataan, Bohol, and Pampanga showing a gain of eight provinces from the preceding year.

Glanders.—One case followed by death from glanders was reported in Manila and three in Tarlac.

Bovine contagious pleuropneumonia.—As in the previous year chronic cases of this disease were encountered at the Sisiman slaughterhouse, Mariveles, Bataan among cattle imported from Australia.

Tuberculosis.—During the year a number of carcasses or parts of carcasses were condemned in the Azcarraga and Sisiman slaughterhouses for tuberculosis. A systematic testing of all dairy cattle in Manila, the Trinidad Agricultural School, and the Alabang Stock Farm by the intradermal method was conducted, a report of which is submitted elsewhere in this report.

Sarcosporidiosis.—Sarcocystis sp. has been found in about 90 per cent of all carabaos slaughtered in the slaughterhouse of Tarlac, the capital of the Province of Tarlac.

Fowl diseases.—The Avian pest which killed many birds about three years ago, broke out again during the last quarter of the year in Manila and Rizal.

VETERINARY RESEARCH LABORATORY

The total number of animals used was 1,341 costing ₱89,382.50, or an average cost per head of ₱66.52. As the revenue derived from sales amounted to ₱5,710.80, the net cost to the Government was ₱83,671.70.

During the year 1,330,620 cubic centimeters (445,540 cattle doses) of vaccine was manufactured, and the amount on hand December 31, 1928 was 40,317 cubic centimeters, making a total of 1,370,937 cubic centimeters of which 1,342,601 cubic centimeters of 447,533 cattle doses were used in the campaign against rinderpest, leaving a balance on hand December 31, 1929 of 28,336 cubic centimeters, equivalent to 9,445 cattle doses.

During the year, 56,033 cattle and 160,327 carabaos were vaccinated, making a total of 216,360 animals, using a total of 384,003 cattle doses. The largest amounts of vaccine were used in Nueva Ecija, 97,132; Isabela, 63,872; Tarlac, 58,170; Antique, 44,637, and Nueva Vizcaya, 29,451 cattle doses.

Anti-rinderpest serum.—In view of our continued success in immunizing animals at this station by the use of rinderpest vaccine followed by virus, no animals were immunized by the simultaneous method at this station during the past year. However, due to an arrangement between the Director of Agriculture and Mr. Ramon Soriano, who was awarded a contract to import Indo-Chinese cattle and carabao, whereby we would receive one-half of such amount of serum as Mr. Soriano desired, a total of 14,632 cubic centimeters of antirinderpest serum valued at ₱234.12 was manufactured from these animals during the year. The amount on hand, December 31, 1928, was 28,195 cubic centimeters, making a total of 42,827 cubic centimeters. In the month of November 7,500 cubic centimeters of serum was sold to the Calamba Sugar Estate and 942 cubic centimeters was condemned due to age, making a total of 8,442 cubic centimeters. There was a balance on hand December 31, 1929 of 34,385 cubic centimeters.

BIOLOGICAL PRODUCTS

Hog cholera virus continued to be manufactured by this laboratory. A total of 5,300 cubic centimeters was produced during the year. While this virus is maintained primarily for the use of the Bureau, private parties and practitioners were supplied from time to time. The total amount dispensed during the year was 1,598 cubic centimeters, as per attached report.

Avian pest virus.—Approximately 1,000 cubic centimers of liquid virus and 20 grams of dried organs were prepared last year.

Avian pest vaccine.—Approximately 600 cubic centimeters of Avian pest vaccine was prepared for experimental purposes. The results obtained were encouraging. Single, double and triple injections were tried.

Anti-avian pest serum.—One hundred ninety cubic centimeters of anti-avian pest serum was prepared this year. Of this amount, 175 cubic centimeters was used for experimental purposes, leaving a balance of 15 cubic centimeters on hand.

Rabies, street virus.—Twenty grams of street virus, prepared for experimental purposes, is now on hand.

Rabies, fixed virus.—Fixed virus used in the manufacture of rabies vaccine. The strain which we use came from the Bureau of Science. The amount of 5 grams is now on hand.

Rabies vaccine.—We have manufactured 650 cubic centimeters of rabies vaccine by the penol-killed method. This vaccine is now being tested for potency on dogs in the City Pound and rabbits in the laboratory, using the single injection method.

Stock surra trypanosomes.—A strain of surra trypanosomes obtained from Major R. A. Kelser two years ago, is carried on in guinea pigs.

Positive surra serum.—We have on hand 50 cubic centimeters of positive horses serum obtained from a horse suffering from experimental surra. This is used as a control in the complement fixation tests for surra.

Anti-sheep hemolytic amboceptor.—We have on hand 100,000 units of anti-sheep amboceptor of high titre. We are in a position to perform complement fixation tests as an adjunct in our diagnostic work.

Positive melitensis serum.—We have 25 cubic centimeters of serum from Pnom-Penh cattle which very strongly agglutinates the abortus and melitensis antigen. This serum is being kept for use as a control in agglutination tests for melitensis and abortus organisms.

Stock B. abortus and B. melitensis cultures.—These were obtained from the U. S. Army Medical Research Board, Manila, to be used for making antigen for agglutination tests as an adjunct in our diagnostic work.

Autogenous bacterin.—Two hundred cubic centimeters of autogenous bacterin were prepared for the treatment of an elephant in the Manila Zoölogical Garden.

See attached report for biological products received from the United States and dispensed from this Laboratory during 1929.

LABORATORY DIAGNOSIS SERVICE

Laboratory diagnosis service was extended to the Philippine Health Service, the Alabang Stock Farm, Agusan Coconut Co., San Miguel Dairy Farm, Novaliches Dairy Farm, field veterinarians and private parties. The animals involved were cattle, carabaos, horses, mules, an elephant, dogs, geese, a pheasant and chickens. Specimens were received in the laboratory in the form of blood, blood smears, feces, organs in the fresh and preserved states, parasites, dead and sick animals.

FORAGE AND FORAGE CROPS

As previously reported, the principal green forage grasses grown in the laboratory fields were Guinea grass, Napier grass, Japanese cane and corn, the first two covering most of the ground space, as experience has shown that these grasses are the most suitable for our purposes. All the green feed consumed during the year was grown in the laboratory fields and

those of the Pandacan Quarantine Station. The amount of green feed grown and fed to animals was 457,711 kilos, of which 169, 550 kilos was grown at the Pandacan Quarantine Station, the value estimated to be ₱3,288; and 288, 161 kilos grown at the laboratory, value placed at ₱5,771.40. Some 241,315 kilos of rice straw was purchased costing ₱4,637. Mixed feed of 3,830 kilos was received from Alabang Stock Farm, having a value estimated at ₱303. One thousand two hundred fifty kilos of copra meal was purchased costing ₱75. The total value of the forage is placed at ₱14,074.40, as per itemized report appended herewith.

During the dry season, fresh water for irrigating the forage fields was supplied from Pasig River by a centrifugal pump installed at the Quarantine station. The operating expense averaged ₱6 per day for labor, fuel, and oil.

ILOILO QUARANTINE STATION

Mr. Ramon Soriano having been granted a permit to import carabaos and cattle for work purposes from Pnom Penh, French Indo-China, at about the beginning of the year, reconstructed the six animal sheds he was using in this station. These sheds can hold 340 carabaos at a time. During the year Mr. Soriano brought to this station five shipments of animals consisting of 1,158 carabaos and 175 cattle. All these animals were given the test injections for immunity against rinderpest and subjected to quarantine in accordance with administrative order No. 58 of the Bureau of Animal Industry.

Twelve carabaos and one beef died of rinderpest, one carabao of chronic pneumonia, one carabao of general debility and one beef from an accident. Only about one-half of the rinderpest cases were due to reaction from the test; the rest came already in the incubation period of the disease.

During quarantine forty positive cases of surra were found among the carabaos. Twenty-eight of these belonged to the fourth shipment.

No other communicable diseases were registered among the animals during quarantine. The second shipment brought some suspects of foot-and-mouth disease but the cracks in the coronary band were probably due to soaking or maceration of the feet of the animals in the hold of the ship during the trip.

There is also in this quarantine station a small laboratory which serves as a distributing center of anti-rinderpest vaccine

for the district of Iloilo, which comprises the Provinces of Iloilo, Occidental Negros, Capiz, and Antique.

SISIMAN QUARANTINE STATION AND SLAUGHTERHOUSE

During the year Mr. Ramon Soriano brought to this station 14 shipments of Australian cattle. Two horses were also brought from Australia but on the day of their arrival at the station were transhipped to Manila on the steamer *Mundaca.*

A table showing the number of Australian cattle slaughtered in this station during the year and the number of carcasses and parts condemned with the causes for condemnation is given elsewhere in this report.

ANIMAL HUSBANDRY SECTION

ALABANG STOCK FARM

The animals kept in this farm are cattle, horses, swine, sheep, goats, rabbits, and poultry of different breeds.

The weather conditions were favorable for the animals and crops. About 100 hectares of the pasture were cleared. Forage fields crop were grown as well as palay for feed. A total of 314,963 kilos of feed valued at ₱5,365.43 were produced in this farm. This consisted of guinea, Para grasses, palay, bulang, balili, corn stalks, corn grain, palay, mani hay, cassava roots, camote roots, rice straw and rice hay. Imported feed was fed to imported stock and partly to the young of these raised at the farm.

Horses.—The death of the Welsh stallion left the station with no sire to breed until August 5 when another imported Welsh stallion was sent to the farm. However, on December 31, 6 Arabian stallions arrived from Bombay. Welsh pony was able to serve 11 mares before the end of the year.

One mestizo Arab stallion was sold for ₱610 and one mestizo pony for ₱250.

The total offspring by the Arab stallion "Dick" are three males and eleven females.

The Welsh pony property No. 725 produced 9 foals at the station, three of which were male and six female.

Cattle.—The crossing of the two Ayrshire bulls with Indian and with mestiza Ayrshire-Indian was continued. The big bull property No. 1–A served 18 cows and sired 7 calves. The small Ayrshire bull property No. 2–A served 8 cows, and sired 2 calves.

The $\frac{3}{4}$-Ayrshire heifers have good conformation and are more promising than the $\frac{1}{2}$-Ayrshire.

The native cattle as compared with the Indian and meztiza Ayrshire keep in good condition throughout the year with what they get from the pasture. Some of the native cows that have been milked have produced better than some of the $\frac{1}{2}$-Ayrshire-Indian cows. The Indian buffalo bull used for crossing with native carabao cows is a very active breeder but is very pugnacious.

An intradermal tuberculine test taken of all the dairy cows and bulls proved negative.

Swine.—There was an outbreak of pneumonia among the pigs that caused the death of a number of them. Those that survived were stunted and disposed of for meat.

The Poland-Chinas are growing more popular for they stand the climate well, are big and fast growers. For grading Batangas and Jalajala pigs the results for the first and second generations are very satisfactory.

The Berkshire have in general decreased in size as is especially noticeable among the offspring of the Australian boar bought in 1927.

The Duroc-Jersey are also degenerating.

Goats and sheep.—The Nubian goats are doing well but neither the $\frac{1}{2}$-or $\frac{3}{4}$-Nubian grades give as much milk as the Indian-Maltese which are not only heavier yielders but bigger in size.

Much favorable comment is received on the Shropshire sheep of this station. The offspring with the Indian and grade Shropshire ewes are big, of good conformation and much improved. The sheep in this station are more resistant than the goats but they cannot, however, stand the heat as well as the goats.

Poultry.—Of the American imported breeds of chickens the Rhode Island Reds are the most hardy and suitable to local conditions, with the white Leghorns second. The average number of eggs produced by each breed is as follows:

Buff Orpington	47.5
Cantonese	90.2
Dark Cornish	62.6
Barred Plymouth Rock	97.9
Black Minorca	54.0
Light Brahma	61.8
Buff Cochin	51.1
Rhode Island Red	82.1
White Leghorn	71.5
Buff Orpington-Cantonese	88.0

Number of eggs laid during the year:

January	2,703
February	3,397
March	2,578
April	2,920
May	2,811
June	2,377
July	1,989
August	1,152
September	1,080
October	1,609
November	1,413
December	1,763
Total number of eggs laid during the year	25,795

A total of 25,795 eggs were laid on the farm during the year. Observations in previous years show that molting takes place between June and November and that the most favorable season for chick raising is from November to March. The newly imported Autralorps and White Leghorns, placed in a new colony house and on new ground, are now doing fairly well.

The White kings, Homer and native pigeons are doing well. The first are slow to multiply and are not as hardy as the Homers. A total of 510 squabs were sold this year.

Rabbits.—The rabbits placed on the farm are of ordinary type. There is quite a demand for them as pets and at the same time for meat so that plans have been made to import a better breed from California known as White Giants.

LA CARLOTA STOCK FARM

Cattle.—The cattle sold, mostly for meat, totaled 505 head and brought ₱13,664. The new Sussex bulls are being crossed with Indian cows from the Government and privately-owned cows. The grade Sussex get the color from the Sire. There are now 14 mestizo Sussex (4 males and 10 females), all in good condition. The Sussex bulls are fed with imported feed consisting of timothy and alfalfa hays and wheat bran, supplemented with green feed and native mixed feeds. The mestizos, although accustomed to native feed, are from time to time fed imported feed also.

The carabao herd consists of two Indo-Chinese carabao bulls, one native carabao bull, 19 carabao cows and 23 young stock and also 31 castrated carabaos are used for work purposes.

There are still at this farm cattle and carabao bulls under observation as to the effect of castration when six months old and when two years old to check the common belief that the castration of the older stock makes them better suited for work purposes.

Swine.—The pure-bred pigs sent to the station declined in health and those raised are stunted if not completely runted. This is suspected to be due largely to intestinal worm parasites. The grade pigs do better and those on hand are doing well.

Sheep.—The sheep were heavily culled. Out of 66 at the beginning of the year and four births, there remain 8. Six died and 56 were sold.

Poultry.—The demand for poultry and eggs shows great interest among the people. The supply has always been much less than the demand. White Leghorn roosters have for some time been crossed with native and the results are promising.

CEBU BREEDING STATION

This station raises poultry and swine and has the care of the breeding sires used largely for public breeding. The demand for pure bred pigs and poultry is more than the station can supply.

The station made ₱1,350.64 this year. There are 18 sires used for public breeding work: 2 grade stallions, 3 Indian bulls, 4 rams, 2 bucks, and 7 boars.

BAYOMBONG CATTLE BREEDING STATION

This is a cattle-breeding station and only pure-bred Indian Nellores are raised here. Of the 47 cows 26 calved during the year. Twenty-five head of cattle were sold at public auction for ₱775. Twelve bulls of this farm are out, loaned to cattle raisers; 9 of these are in Nueva Vizcaya and 3 in Ifugao and all are reported as going with 205 cows, while 105 offspring were reported as the get from crossings.

PUBLIC BREEDING

There are few sheep raised in this station. The defect in the project lies in the insufficiency of breeding sires and the use of old stock. This forced the closing of the Batangas Breeding Station and of the Oriental Negros Breeding Station. The breeding stallions in La Carlota, Cebu, Jolo, and Iwahig Penal Colony are now very old and will have to be disposed of, if new breeding stallions are available next year.

At Alabang and Bayombong stations, the public breeding is being extended over a wide territory from year to year.

COÖPERATIVE STATION

The following are the coöperative stations of the Bureau under different Government entities: Bureau of Education: Bukidnon Agricultural School, Malaybalay, Bukidnon; San Carlos Agricultural School, San Carlos, Pangasinan; Bureau of Prison; Iwahig Penal Colony, Iwahig, Palawan; Provincial Governments: Santa Barbara Poultry-Swine Station, Santa Barbara, Pangasinan.

DIVISION OF PUBLICATIONS

There were published one annual report, 4 issues of the *Philippine Agricultural Review*, 4 issues of the *Ang Magsasakang Pilipino*, 8 new circulars, 8 old ones, 1 Miscellaneous Agricultural Information, 4 miscellaneous publications, 6 posters and 12 articles for the local papers. During the year 148,823 of these publications were distributed.

THE PHILIPPINE AGRICULTURAL REVIEW

In the 4 issues, 25 treatises, articles, etc., were published. Four thousand nine hundred fifteen copies of the Review were mailed to subscribers or sold to private parties.

ANG MAGSASAKANG PILIPINO

Of the 4 issues, one was Swine Breeding Issue. There is an increasing demand for this journal. Over 14,800 copies were mailed to farmers in the Tagalog provinces.

BULLETINS

No new bulletin was published, but 1,743 of the old bulletins were distributed.

CIRCULARS

Seven new circulars were released and 8 old ones reprinted. The following are the new circulars:

No. 230.—Bleaching of Philippine Abaca—Two Methods of Raising the Grade of Manila Hemp by H. E. Sherman.

No. 231.—Grafting the Lanzon, by P. Padlan and F. Abaya.

No. 232.—The Propagation of Coffee from Seeds in the Nursery by F. G. Galang.

No. 233.—Notes on Lumbang.

No. 235.—Directions for the Control of the Avian Pest.

No. 236.—Papaya Culture, by E. K. Morada.

No. 237.—The Natural Storage and Curing of Batangas Mandarin Oranges in an Underground Cement Chamber, by Jose de Leon.

MISCELLANEOUS AGRICULTURAL INFORMATION

Volume IV of Miscellaneous Agricultural Information, consisting of 30 pages was published. Four hundred copies of this booklet were mimeographed and bound and distributed to the field personnel of the Bureau.

MISCELLANEOUS PUBLICATIONS

The following were published during the year:

Miscellaneous Papers on Sugar Cane and Fertilizers.
The Most Common Dangerous Communicable Diseases of Domestic Animals and Their Control (Eng., Spanish, Tagalog, and Visayan).
Storing Farm Crop Seeds.
Ang Pagpapaunlad ng Pananim na Dalanghita at iba pang Sitro sa Lalawigan nang Batangas, by Jose de Leon and Faustino Marajas.

There were 10,924 miscellaneous publications distributed.

POSTERS

Six new posters were published, namely, Rice Cut Worms; Rice Army Worms; Worms that Eat the Cabbage; The Coconut Beetle; Rice Stem Borer (Tagalog); and the Leaf Miner Beetle (in preparation).

Over 10,500 posters were distributed.

ARTICLES IN THE PRESS

The division prepared or edited articles by some of the Bureau personnel which were published in some of the local dailies and journals. The most important of these are as follows:

Upland Rice Planting, by Jose S. Camus. (The Philippine Herald.)
The Animal Industry, by Carlos X. Burgos. (The Philippines Herald.)
The Work of the Plant Investigations Division, by M. Manas y Cruz. (The Philippines Herald.)
Pest Control and Agriculture, by Gonzalo Merino. (The Philippines Herald.)
The Philippine Agricultural Industries, by J. Q. Dacanay. (The Philippines Herald.)
Como Ayuda la Oficina de Agricultura al Desarrollo de la Industria Azucarera, by Silvestre Asuncion. (La Vanguardia.)
Guia para la Fabricación de Panocha, by Anselmo Labrador. (La Vanguardia.)
La Industria Cocotera, by J. Q. Dacanay. (El Debate.)
The Accomplishments of the Bureau of Agriculture, by Jose S. Camus. (The Philippines Herald.)

The Government Sugar Cane Experiment Station, by Silvestre Asuncion. (The Philippines Herald.)
The Carabao, an Aid to the Sugar Planter, by Carlos X. Burgos. (The Philippines Herald.)
The Mediterranean Fruit Fly, by Gonzalo Merino. (Graphic.)

Besides the above articles there were also other articles prepared and edited by this division and published in the *Philippines Farm Journal.*

LIBRARY

Accessioning.—There were 96 books accessioned during the year.

Binding.—One hundred sixty-eight volumes were sent to the Bureau of Printing for binding.

Subscriptions, exchange, and donations.—The library subscribed to 35 journals and local papers, received 160 in exchange and also received and sorted for reference about 1,430 bulletins, circulars, pamphlets, leaflets and reports from the United States and other countries.

Articles clipped.—During the year there were about 1,762 articles clipped and kept in the library.

Cuts handled.—The library handled 3,792 cuts during the year.

OTHER ACTIVITIES

Press items.—Besides these articles published in the local press 370 pages of news notes were released.

Translations.—Eight hundred eighty-nine pages of manuscripts, letters and miscellaneous materials were translated; of which 570 were into Spanish and 390 into Tagalog.

Typewriting work.—There were 4,200 manuscripts, letters, translations, and miscellaneous articles typed in the division.

Photographic work.—Four hundred sixty-four plates, 363 prints, 180 slides and 60 transparencies were developed and 53 enlargements and 3,926 prints were made.

Printing machines.—The work done on the multigraph and mimeograph machines is shown in the following table:

	1928	1929	Increase (+) Decrease (—)
Multigraph:			
Work orders	110	114	+ 4
Copies printed	747,587	551,247	— 196,340
Mimeograph:			
Work orders	780	748	+ 38
Copies printed	1,270,511	1,381,938	— 111,437

FARM STATISTICS DIVISION

While the tendency of many farmers is to underestimate the yields obtained from their farms, fearing that the purpose of this Office in making such inquiries is to increase their taxes or check their incomes, the division has received also valuable assistance from many individual farmers and especially from coconut oil and desiccated coconut factories, sugar centrals and planters' associations. Their valuable help has materially aided the division in checking the figures obtained from other sources and in offsetting the underestimates of the timorous correspondents, bringing about a higher degree of accuracy in the figures prepared by this division.

The division gathers information for forty different crops, but owing to the lack of sufficient personnel only nine crops are completely finished at the time when the annual report of the division is submitted, the remaining 31 crops having to be completed three months later.

SOME CHEMICAL DIFFERENCES BETWEEN ABACÁ AND CANTON FIBERS

By HARTLEY EMBREY SHERMAN
Chemist, Bureau of Agriculture

Canton is the fiber obtained from a plant said to be a hybrid standing midway between the edible banana and the abacá plant (*Musa textilis*). It bears nonedible fruit somewhat like shriveled bananas. In the field the Canton is easily distinguished from the abacá plant on account of the different leaf formation of the two plants. The leaf of the Canton is rounder than that of the abacá, in this respect resembling more the leaf of the banana.

There are several types of Canton but these are all readily identified in the field. However, there has always been considerable difficulty in distinguishing the stripped fiber of the Canton from abacá fiber. There is apparently a great deal of guess work done even by experienced fiber inspectors. This is proved day by day in the often striking different classification made of doubtful fibers. The manager of one of the largest exporting firms in the Philippine Islands recently declared that he could detect Canton fiber better when he placed the fibers in question behind his back and felt them. He said that Canton had a distinctive and peculiar "feel." He also stated that in large quantities Canton fiber has a distinctive odor—rather like new mown hay.

Distinctives of "feel" and "smell" are always found to be decidedly elusive, and not very definite. The research work in this paper was undertaken in an attempt to find chemical differences between abacá and Canton—something which would prove more uniform and trustworthy than the individualistic senses of "feel" and "smell."

In the past other laboratory workers have also attempted to differentiate between the two fibers by chemical means. It has been repeatedly stated by certain writers that it was possible to distinguish between abacá and Canton fibers by the color of the ash. According to these workers the ash of abacá fiber is slate gray in color, whereas that of Canton is creamy white.

The work written up by P. W. L. Sherman in the *Philippine Journal of Science* in September 1928 showed this belief to be wrong. Further work by the present writer confirmed the work of Sherman, and proved that the ash of abacá may be *of almost any color as also may the ash of Canton.*

The following names of the colors of the ash of abacá fibers were obtained by comparison with the charts in "Color Standards and Color Nomenclature" by Robert Ridgway, Washington, D. C. 1912.

The samples were obtained personally by the writer from individual plants in the field in the Bicol regions.

The fibers were ashed at dull red heat in an electric muffle, the final ashing being done in a current of air to insure complete oxidation.

Abacá sample	Variety	Color of ash
No. 1	Binobui	Artemesia green.
No. 2	Hagenoy	Pale mouse gray.
No. 3	Pulá	Deep mouse gray.
No. 4	Putí	Pale olive gray.
No. 5	Hagpas"	Dark mouse gray.
No. 6	Hagenoy	Olive gray.
No. 7	"Hagpas"-Pulá	Dark olive gray.
No. 8	Puti	Gnaphalium.
No. 10	Agenoy	Smoke gray.
No. 11	Panaon	Deep bluish gray green.
No. 12	Hagenoy	Deep grayish olive.
No. 13	Puti	Pale smoke gray.
No. 14	Puti	Artemesia green.
No. 15	Hagenoy	Grayish olive.
No. 16	Puti	Do.
No. 17	Bungalanon	Light grayish olive.
No. 19	Puti	Do.
No. 20	Itom	Pale smoke gray.
No. 21	Palayog	Court gray.
No. 22	Bungalanon	Deep grayish olive.
No. 23	Itom	Smoke gray.
No. 24	Puti	Deep olive gray.
No. 25	Itom	Grayish blue green.
No. 26	Bungalanon	Deep olive gray.
No. 27	Itom	Pale olive gray.
No. 28	Itom	Light olive gray.
No. 29	Puti	Do.
No. 30	Itom	Deep olive gray.
No. 31	Puti	Do.
No. 32	Puti	Do.
No. 33	Itom	Do.
No. 34	Puti	Do.
No. 35	Itom	Pale olive gray.
No. 36	Puti	Do.
No. 37	Itom	Do.
No. 38	Puti	Olive gray.
No. 39	Itom	Deep glaucous gray.
No. 40	Itom	Avellaneous.
No. 41	Pulá	Deep olive.
No. 42	Puti	Do.
No. 43	Puti	Wood brown.
No. 44	Pulá	Olive bufi.
No. 45	Itom	Olive brown.

The names of the varieties in these tables were given by the workers in the hacienda where the sample was obtained and also by the fiber inspector of Albay, Mr. Flores, as being the common local name for the samples taken. ("Puti" means white. "Itom" means black and "Pulá" means red in the local dialect.)

Samples of Canton	Color of ash
No. 9	Light grayish olive.
No. 18	Greenish glaucous blue.
No. 101	Dusky olive-green.
No. 102	Prussian green.
No. 103	Pallid mouse gray.
No. 104	Pale drab gray.
No. 105	Mouse gray.
No. 106	Bluish gray green.
No. 107	Deep bluish gray-green.
No. 108	Pale turquoise green.

An examination of the colors of the ash of abacá and of Canton proves conclusively that there is no one color of ash peculiar to abacá fiber and that the colors of the ash of abacá fibers are duplicated in the colors of the ash of Canton fiber. It would appear rather that the color of the ash of both abacá and Canton fibers was determined largely by the varying inorganic constituents of the soils in the different localities, in which manganese and iron played prominent rôles.

It has also been claimed that abacá fiber could be distinguished from maguey fiber or other fibers in that *abacá is not colored by potassium chromate,* whereas maguey is supposed to be colored by this chemical. The article reporting this work does not state the strength of the potassium chromate, nor the length of time the solution was used nor whether the solution was hot or cold.

In repeating this work the present writer used 1, 2, 5, and 10 per cent, and saturated aqueous solutions of potassium chromate. The solutions were used both hot and cold, for periods of 1 minute, 2, 5, 10, 20, 30, and 40 minutes, and one hour on a number of known samples of abacá fiber of different degrees of coarseness of stripping; on a number of known samples of Canton fiber and on a number of known samples of maguey fiber. The abacá fibers tested represented a number of varie-

ties taken from many different haciendas. In every sample tested, the abacá fibers treated with potassium chromate, when compared with the original untreated fiber, showed a change of color. The change of color was noticeably fainter where the fiber was treated with the more dilute solutions and for shorter periods of time *but there was a change of color in every fiber tested.* There was likewise a similar change in color for all Canton fibers and for all maguey fibers tested in a like manner for the same length of time, with the same strength of aqueous potassium chromate solution. (See Colored plate.) This test appears, then, not to be reliable as a means of distinguishing abacá fibers from maguey or Canton fibers.

In order to study the chemical properties of abacá and Canton, a number of samples of these fibers were collected and their tensile strength was determined on a Louis Schopper Tensile Strength Machine. From twenty to forty fiber bundles of each sample were broken in the machine and the results calculated as the average breaking weight in kilos per gram of fiber per meter long. The percentage of elasticity was also determined on the Louis Schopper Tensile Strength Machine.

The natural acidity of the abacá and Canton fibers under investigation was estimated in the following way: Ten grams of fiber was weighed accurately, and cut into small pieces. This fiber was placed in an Erlenmeyer flask of 500-cubic centimeter capacity. The flask was filled to mark with re-distilled water and flask and the contents were placed over a steam bath for one hour. The liquid was filtered off from the fiber and titrated with tenth normal sodium hydroxide, phenolphathalein being used as an indicator. The results were tabulated as the number of cubic centimeters of N/10 NaOH required to neutralize the acidity of 10 grams of fiber treated in the manner described. This test has been found valuable in the past as giving an indication of the probable keeping quality of abacá. It has been found that normal finely stripped abacá has a low acidity. The amount of acidity increases normally with the coarseness of the stripping, but when a fiber shows an unexpected acidity, an acidity much higher than the usual run of fibers of the same class of stripping, a careful examination of the fiber in question

usually reveals a strong odor of fermentation. Such a fiber usually shows a greatly lessened tensile strength after some months of storage.

The percentage of ash of each fiber investigated was determined in the usual way through ashing in an electric muffle at dull red heat.

Abacá of excellent cleaning

No.	Origin	Tensile strength	Per cent of elasticity	Cubic centimeters of N/10 NaOH neutralizing the acidity of 10 grams	Per cent of ash
		Kilos			
1	Barrio Baribag, Sorsogon	48.391	2.05	.69	2.43
2	Barrio Sipac, Sorsogon	47.561	2.05	.28	2.75
5	Barrio Mapaso, Irosin, Sorsogon	41.127	1.89	1.26	2.70
6	Barrio Balas, Irosin, Sorsogon	54.433	2.06	.67	1.64
7	Do	54.097	2.09	.35	1.90
8	Do	58.484	2.29	.65	1.55
11	Barrio Linonghan, Juban, Sorsogon	60.615	2.39	.68	1.97
12	Barrio Catanusan, Juban, Sorsogon	58.191	2.17	.43	1.45
13	Do	56.270	2.28	.47	.87
14	Barrio Cipaya, Juban, Sorsogon	53.221	2.13	.69	2.35
15	Barrio Malbug, Juban, Sorsogon	45.978	2.15	.76	2.28
40	Tigaon, Camarines Sur	57.269	2.14	.48	.89
41	Do	64.779	2.30	.49	.97
42	Do	54.351	2.02	.50	.86
43	Do	58.159	2.40	.53	.79
44	Do	57.924	2.26	.48	.94
45	Do	59.148	2.17	.57	.88
	Average	54.705	2.16	.58	1.60

Canton of excellent cleaning

No.	Origin	Tensile strength	Per cent of elasticity	Cubic centimeters of N/10 NaOH neutralizing the acidity of 10 grams	Per cent of ash
9	Barrio Balas, Irosin, Sorsogon	42.289	1.77	1.06	2.58
151	Bacacay, Albay	48.056	1.97	70	1.53
152	Do	48.138	1.95	.60	....
153	Tabaco, Albay	63 532	2.45	.55	1.40
154	Do	61.747	2.17	.40	....
155	Libog, Albay	52.286	2.05	.60	2.27
156	Do	47.286	1.82	.60	....
157	Do	61.440	2.27	.50	1.81
158	Do	54.504	2.13	1.10	......
159	Barrio de Cab-Cab, Cabolhon, Catanduanes, Albay	45.640	1.77	.74	1.46
160	Do	48.734	1.80	.52	..
180	Rapu-Rapu, Albay	35.4	1.90	1.30	2.61
181	Do	46.1	1.91	.90	2.25
182	Do	44.8	1.85	1.12	2.30
183	Do	37.8	1.85	1.50	2.78
184	Do	44.0	1.90	1.17	2.46
185	Do	36.6	2.13	1.30	2.65
186	Rapu-Rapu, Albay	41.6	2.28	1.20	3.06
	Average	47.773	1.99	0.88	2.24

Abacá of good to coarse stripping

No.	Origin	Tensile strength	Per cent of elasticity	Cubic centimeters of N/10 Na OH neutralizing the acidity of 10 grams	Per cent of ash
		Kilos			
3	Barrio Mapaso, Irosin, Sorsogon	43.881	1.91	.41	2.79
4	Do	46.296	2.01	.35	1.56
10	Barrio Guruyan, Juban, Sorsogon	49.302	2.15	.64	2.17
16	Barrio San Fernando, Libog, Albay	40.879	2.30	1.12	5.94
17	Do	36.685	2.19	.84	5.29
19	Do	44.927	2.49	1.49	3.37
22	Barrio Bonga, Bacacay, Albay	43.867	2.55	1.02	4.60
23	Do	44.969	2.36	1.31	3.96
24	Do	34.901	2.04	1.72	5.38
26	Do	31.044	1.87	1.99	5.81
28	Barrio San Jose, Malilipot, Albay	38.833	2.05	1.32	3.47
29	Do	44.300	2.50	.98	4.76
31	Do	40.447	2.18	1.17	4.44
32	Do	41.215	2.14	1.34	4.83
33	Do	43.813	2.24	.93	5.57
34	Barrio San Francisco, Malilipot, Albay	44.594	2.22	1.76	4.20
35	Do	47.801	2.16	1.64	4.39
36	Do	48.412	2.40	1.38	4.48
37	Do	44.906	2.32	1.49	4.59
	Average	42.688	2.22	1.20	4.29

Canton of good to coarse stripping

No.	Origin	Tensile strength	Per cent of elasticity	Cubic centimeters of N/10 Na OH neutralizing the acidity of 10 grams	Per cent of ash
18	Barrio San Fernando, Libog, Albay	30.608	1.89	1.27	7.86
102	Submitted by Ross	24.385	1.27	4.83	4.21
103	Submitted by Smith Bell & Co	26.361	1.67	4.38	5.40
104	Submitted by W. F. Stevenson	28.874	1.83	2.63	3.94
106	Submitted by Smith Bell & Co	23.910	1.45	2.75	4.50
107	Cagararay, Bacacay, Albay	26.595	1.83	2.25	7.09
108	Lagonoy, between San Jose and Sabang	40.614	2.17	2.58	5.13
161	Libog, Albay	34.077	1.75	.50	4.87
162	Do	30.160	1.60	1.50	....
163	Do	35.965	1.85	2.12	2.76
164	Do	35.212	1.72	2.82	....
165	Do	34.850	1.77	1.85	3.64
166	Do	32.851	1.67	.83	....
167	Do	29.853	1.55	.70	4.52
168	Do	21.173	1.20	2.00	....
169	Libon, Albay	20.500	1.01	3.00	4.86
170	Do	20.415	1.82	2.30	....
171	Bacacay, Albay	35.7	3.50	.80	5.54
172	Tabaco, Albay	23.6	1.86	5.30	....
173	Bacacay, Albay	27.1	1.79	6.30	6.49
174	Smith Bell & Co., Caramoan, Penn	27.1	1.42	3.13	2.66
175	Barrio de Cab-Cab, Cabolhon, Catanduanes, Albay	23.1	2.33	1.70	....
176	Do	24.3	1.87	4.10	4.97
177	Barrio Caramoan, Pandan, Catanduanes, Albay	26.1	2.01	1.70	....
178	Do	28.0	2.63	.70	6.40
	Average	28.456	1.81	2.4	4.99

A study of the tables shows that the *Canton fibers when compared with abacá fibers of the same stripping show lower tensile strength, a lower percentage of elasticity, a higher acidity and a higher percentage of ash.*

Another test which seemed to help in distinguishing between Canton and abacá fibers is what may be named "The Mercerization Curl." A glass tube a meter long and about three inches in diameter was filled with 20 per cent solution of cold sodium hydroxide. A metric scale was fastened to the back of the tube. Individual fibers were measured off—88 centimeters long, and a little knot was made in each end of the fiber. One end of the fiber—the tip end—was placed over the glass hook of a supporting rod at the top of the tube, and the other end was allowed to hang free in the tube—but weighed down by a small piece of platinum wire, twisted into the lower knot of the fiber. The weight of the platinum wire was chosen so that it was approximately equal in weight to the weight of the individual fiber under experimentation. (See Plates following article.)

Instantly the fiber began to curl and contract. The kind of curl and amount of the curl was noted every minute for ten minutes. At the end of ten minutes the fiber was taken out, washed thoroughly and dried. About 20 fibers from each sample were tested in this way. It was interesting to note an entirely different appearance on the part of the Canton fibers from that shown by the abacá fibers. The Canton fibers seemed to have contracted more than the abacá fibers of like stripping and the curl of the Canton fibers was shorter, tighter, and "kinkier" than that of the abacá fibers, which had a longer and looser curl.

In these photographs, fiber No. 1 is abacá; No. 2 is Canton. Fiber No. 3 is abacá; No. 4 is Canton. Fiber No. 5 is abacá; No. 6 is Canton. Fiber No. 7 is abacá; No. 8 is Canton. Fiber No. 9 is abacá; No. 10 is Canton. In each photograph an abacá fiber is compared to a Canton fiber of the same stripping.

All the fibers in the laboratory—about 43 different samples of abacá and about 20 different samples of Canton—were tested in this way, and they all showed the distinctive difference of curl just described with the exception of one or two samples of commercial Canton. In other words every Canton sample in the laboratory actually taken in the field—from known growing Canton—seemed to follow these distinctions, whereas one or two samples submitted from local export bodegas, and labeled

Canton did not meet the test. This may be explained by the fact that it is illegal to label as "abacá" any fiber containing even a small amount of "Canton," but it is common practice to label as "Canton" any fiber in which there is even the smallest admixture of "Canton." Some commercial samples may contain more than 75 per cent of abacá, yet they must be classified as "Canton." Then, too, there is often a difference of opinion among fiber experts as to the proper classification of some doubtful fibers. One fiber, in particular, was submitted as "Canton," whereas the classifiers of other bodegas called it "wild abacá," and its chemical constants as worked out in the laboratory were like those of known abacá fiber.

The results of this "Mercerization Curl" test proved so interesting that another experiment was devised in an attempt to standardize these differences and place them on a quantitative basis.

Forty fibers one meter long from each fiber sample were dried in an electric oven at 101° C. to constant weight. They were cooled in a desiccator and weighed accurately on an analytical balance. They were then dropped into boiling 1 per cent potassium hydroxide solution and boiled one hour. During the boiling process they were weighed down with small glass rods and the liquid was kept at the initial mark made on the outside of the containing vessel so as to prevent concentration during the boiling in 1 per cent KOH. After boiling one hour the fibers were washed free from alkali, dried to constant weight in the electric oven, weighed and the per cent of loss calculated. This loss evidently represents saponifiable matter and pecto celluloses present in the fiber and was much higher for the Canton tested in the laboratory than for the abacá of similar stripping. The abacá averaged about 18.9 per cent loss for excellent stripping and about 22.9 per cent loss for medium to coarse stripping. The Canton fibers averaged about 26.9 per cent loss for excellent stripping and about 28.8 per cent loss for medium to coarse stripping.

It was interesting to observe that in one or two cases where the abacá fibers had become wet and fermented the per cent of loss from boiling one hour in 1 per cent KOH was higher than in normal unfermented abacá fiber of the same stripping.

Abacá of excellent stripping

No.	Origin	Average weight of fiber 1 meter long	Per cent loss on boiling 1 hour in 1 per cent KOH
		Grams	
1	Barrio Baribag, Sorsogon	.0578	21.1
2	Barrio Sipac, Sorsogon	.0565	21.0
5	Barrio Mapaso, Irosin, Sorsogon	.0571	23.9
6	Barrio Balas, Irosin, Sorsogon	.0450	16.5
7	Do	.0379	16.25
8	Do	.0397	16.85
11	Barrio Linong-han, Juban, Sorsogon	.0482	19.9
12	Barrio Catanusan, Juban, Sorsogon	.0290	18.1
13	Do	.0278	18.0
14	Barrio Cipaya, Juban, Sorsogon	.0368	20.1
15	Barrio Malbug, Juban, Sorsogon	.0567	20.2
40	Tigaon, Camarines Sur	.0300	17.5
41	Do	.0300	15.2
42	Do	.0365	17.1
43	Do	.0234	[a] 22.2
	Average	.0408	18.92

[a] Got wet and fermented slightly.

Canton of excellent stripping

No.	Origin	Average weight of fiber 1 meter long	Per cent loss on boiling 1 hour in 1 per cent KOH
		Grams	
9	Barrio Bolos, Irosin, Sorsogon	.0189	25.3
151	Bacacay, Albay	.0104	31.3
152	Do	.0101	22.6
153	Tabaco, Albay	.0101	24.1
154	Do	.0154	25.9
155	Libog, Albay	.0121	32.8
156	Do	.0131	31.3
157	Do	.0139	25.5
158	Do	.0146	25.5
159	Barrio de Cab-Cab, Cabolhon, Catanduanes, Albay	.0149	25.9
160	Do	.0111	26.1
	Average	.0131	26.9

Abacá of good to coarse stripping

No.	Origin	Average weight of 1 fiber 1 meter long	Per cent loss on boiling 1 hour in 1 per cent KOH
		Grams	
3	Barrio Mapaso, Irosin, Sorsogon	.0837	20.9
4	Do	.0745	20.8
10	Barrio Guruyan, Juban, Sorsogon	.1296	19.4
16	Barrio San Fernando, Libog, Albay	.1406	24.1
17	Do	.1997	23.5
19	Do	.0732	20.9
22	Barrio Bongan, Bacacay, Albay	.1013	23.8
23	Do	.1112	23.7
24	Do	.1010	23.3
26	Do	.1068	25.0
28	Barrio San Jose, Malilipot, Albay	.1040	24.8
29	Do	.0888	24.4
31	Do	.0906	22.6
32	Do	.08296	24.7
33	Do	.0973	22.1
34	Barrio San Francisco, Malilipot, Albay	.1165	22.2
35	Do	.1158	23.6
36	Do	.0926	23.1
37	Do	.1128	23.1
	Average	.10647	22.9

Canton of good to coarse stripping

No.	Origin	Average weight of 1 fiber 1 meter long	Per cent loss on boiling 1 hour in 1 per cent KOH
		Grams	
18	Barrio San Fernando, Libog, Albay	.0955	29.9
102	Submitted by Ross	.1109	28.2
103	Submitted by S. B. & Co.	.1274	34.3
104	Submitted by W. F. Stevenson	.1394	27.5
106	Submitted by S. B. & Co.	.0657	29.5
107	Cagararay, Bacacay, Albay	.1505	29.9
108	Lagonoy	.0648	26.0
165	Libog, Albay	.0489	27.3
166	Do	.0505	28.8
167	Do	.0639	29.6
169	Libon, Albay	.0895	28.9
170	Do	.0870	26.4
	Average	.0911	28.8

There have always been such persistent statements of a characteristic "feel" to Canton fiber that an experiment was performed to show what were the differences existing in the actual fat content of the two fibers. About 20 grams of each sample of fiber was dried to constant weight in an electric oven and then weighed. The dried fibers were extracted three hours in a Soxhlet apparatus with anhydrous ether and the per cent of ether extract determined as the percentage of loss of weight of the original fiber. A comparison of the tables showed an average of 0.29 per cent of ether extract for abacá of excellent stripping; an average of 0.42 per cent of ether extract for abacá of medium to coarse stripping, whereas Canton fibers of medium to excellent stripping showed an average ether extract of 1.05 per cent, and an average of 1.00 per cent of ether extract for Canton fibers medium to coarse stripping.

Another interesting observation was made of the fact that Canton fibers stripped with the same knife, by the same workers—from tests made in the laboratory seem to be lighter in weight than abacá fibers of exactly the same stripping. Sample of abacá No. 7 showed an average weight of .0379 gram for an individual fiber one meter long; abacá sample No. 8, an average weight of .0397 gram for an individual fiber 1 meter long, whereas Canton sample No. 9 stripped with the same knife showed an average weight of .0189 gram of one individual fiber one meter long.

Sample No. 16 of abacá showed an average weight of 0.1406 gram for an individual fiber 1 meter long; sample No. 17 of abacá showed an average weight of 0.1997 gram for an indi-

vidual fiber 1 meter long, whereas Canton sample No. 18—stripped under the same knife by the same worker—showed an average weight of .0955 gram for an individual fiber one meter long. (The average weights were the averages of at least 40 weights of individual fibers from each sample.)

Abacá of excellent stripping

No.	Origin	Average weight of 1 fiber 1 meter long	Percentage of ether extract
		Grams	
1	Barrio Baribag, Sorsogon	.0578	.22
2	Barrio Sipac, Sorsogon	.0565	.31
7	Barrio Bolos, Irosin, Sorsogon	0379	.35
8	Do	.0397	.27
11	Barrio Linonghan, Juban, Sorsogon	.0482	.08
12	Barrio Catanusan, Juban, Sorsogon	.0290	.36
13	Do	.0278	.42
14	Barrio Cipaya, Juban, Sorsogon	.0368	.49
15	Barrio Malbug, Juban, Sosogon	.0567	.25
40	Tigaon, Camarines, Sur	.0300	.26
41	Do	.0300	.31
42	Do	.0365	.25
43	Do	.0234	.27
44	Do	.0124	.38
45	Do	.0265	.11
	Average	.0366	.29

Canton of excellent stripping

No.	Origin	Average weight of 1 fiber 1 meter long	Percentage of ether extract
		Grams	
9	Barrio Balos, Irosin, Sorsogon	.0189	1.05
151-152	Bacacay, Albay	.0102	.79
153-154	Tabaco, Albay	.0127	.73
155-156	Libog, Albay	.0126	1.39
157-158	Do	.0142	1.13
159-160	Barrio de Cab-Cab, Cabolhon, Catanduanes, Albay	.0147	1.20
	Average	.0139	1.05

Abacá of good to coarse stripping

No.	Origin	Average weight of 1 fiber 1 meter long	Percentage of ether extract
		Grams	
4	Barrio Mapaso, Irosin, Sorsogon	.0745	.10
10	Barrio Guruyan, Juban, Sorsogon	.1296	.45
16	Barrio San Fernando, Libog, Albay	.1406	.69
17	Do	.1997	.76
35	Barrio San Francisco, Malilipot, Albay	.1158	.14
36	Do	.0926	.26
37	Do	.1128	.52
	Average	.1236	.42

Canton of good to coarse stripping

No.	Origin	Average weight of 1 fiber 1 meter long	Percentage of ether extract
		Grams	
18	Barrio San Fernando, Libog, Albay	.0955	1.24
103	Submitted by Smith Bell & Co	.1274	1.20
104	Submitted by W. F. Stevenson	.1394	.64
106	Submitted by Smith, Bell & Co	.0657	.73
107	Cagararay, Bacacay, Albay	.1505	1.14
108	Lagonoy, between Sabang and San Jose	.0648	.62
174	Smith, Bell & Co., Caramoan Penn	.0839	1.35
182	Rapu-Rapu, Albay	.0296	1.12
	Average	.0946	1.00

SUMMARY AND CONCLUSIONS

While no claim is made that all Canton and abacá fibers follow these rules, it is asserted that the samples of abacá and Canton examined in the laboratory gave these results:

(1) A variety of overlapping colors of the ash for both of these fibers and no distinctive color of ash for either fiber; so that the *color of the ash is of no value in differentiating* abacá from Canton.

(2) Both fibers were colored by potassium chromate solution in various strengths of solutions. *This test appears of no value* for classifying Canton and abacá.

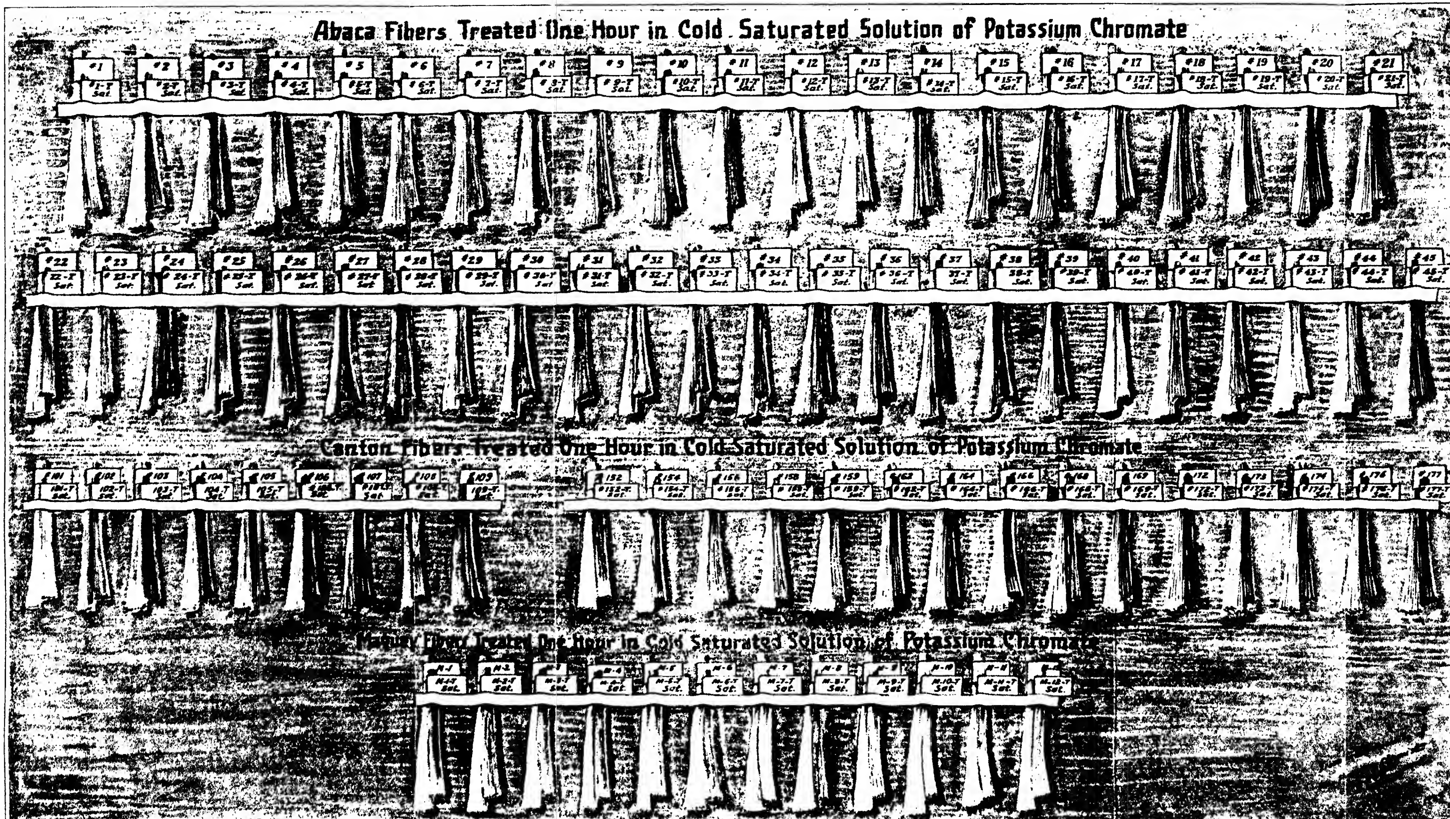
(3) Canton fibers showed average lower tensile strengths, average lower percentage of elasticity, average higher natural acidity and average higher percentage of ash than abacá fibers of similar stripping.

(4) Canton fibers stripped with the same knife as abacá fibers—and by the same workers—were lighter in weight than the abacá fibers of similar stripping.

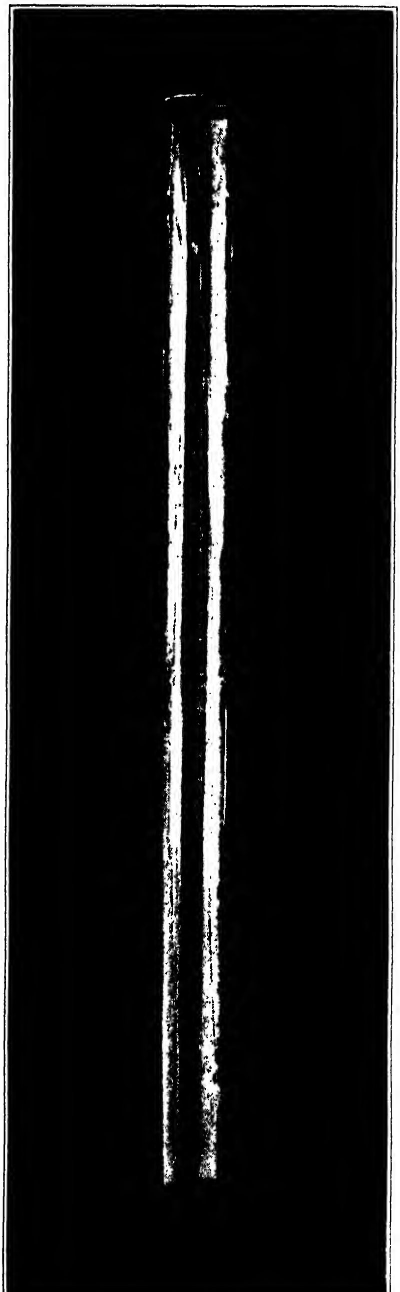
(5) The "Mercerization Curl" produced with 20 per cent NaOH as outlined in this paper gave tighter, kinkier curls and greater contraction with Canton fiber than with abacá fiber of similar stripping.

(6) The average percentage of loss on boiling one hour with 1 per cent KOH was about 6 per cent higher for Canton fibers than for abacá fibers of the same stripping. This seems to indicate a larger amount of saponifiable matter and of pectocelluloses in Canton fibers than in abacá fibers.

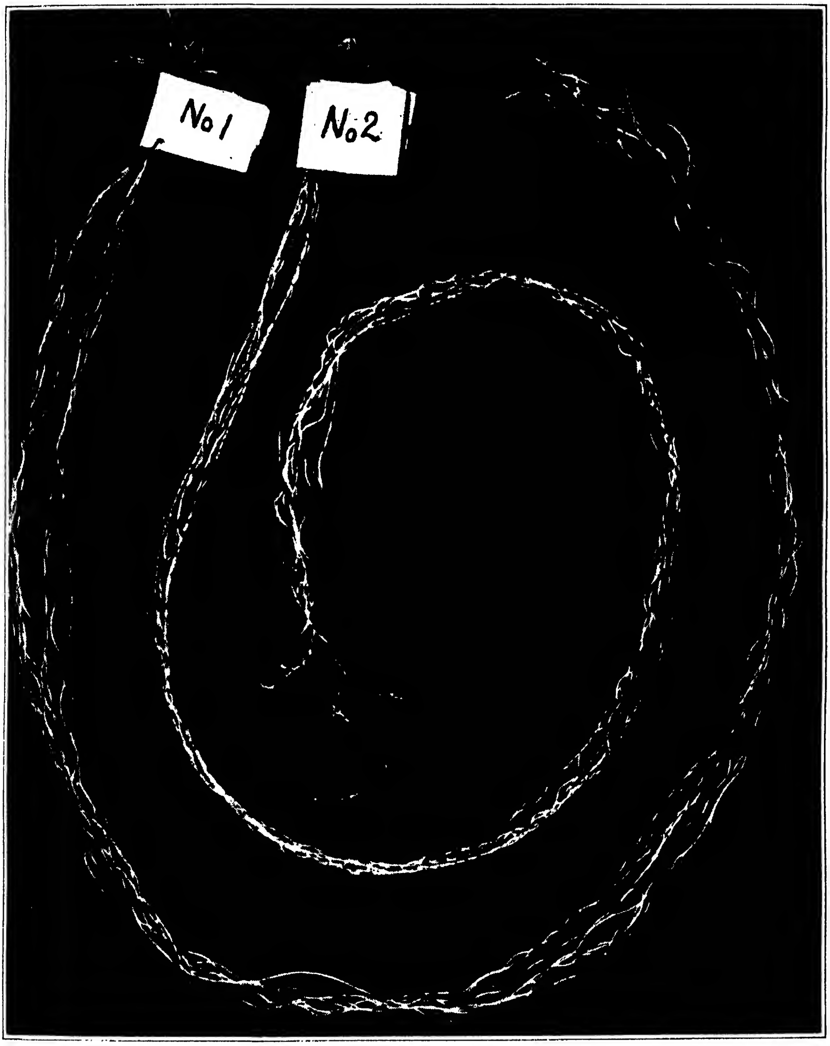
(7) The ether extract of Canton fiber is around one per cent whereas the ether extract of abacá fibers is from 0.2 to 0.4 per cent. The characteristic "feel" of Canton is probably due to a real quantitative difference of fat present. The fat of Canton fibers tested in the laboratory was from *2 to 3 times greater* than that of abacá fibers of the same stripping.



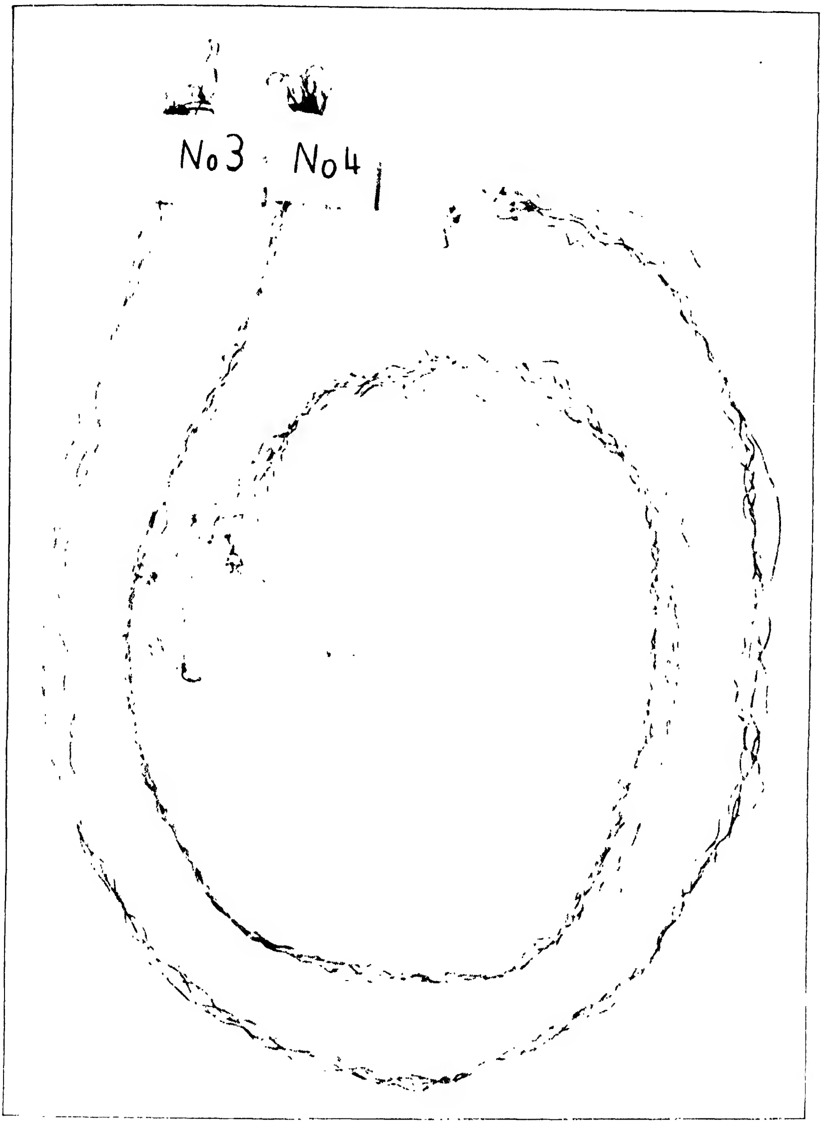
ABACÁ, MAGUEY, AND CANTON FIBERS COLORED BY POTASSIUM CHROMATE SOLUTION



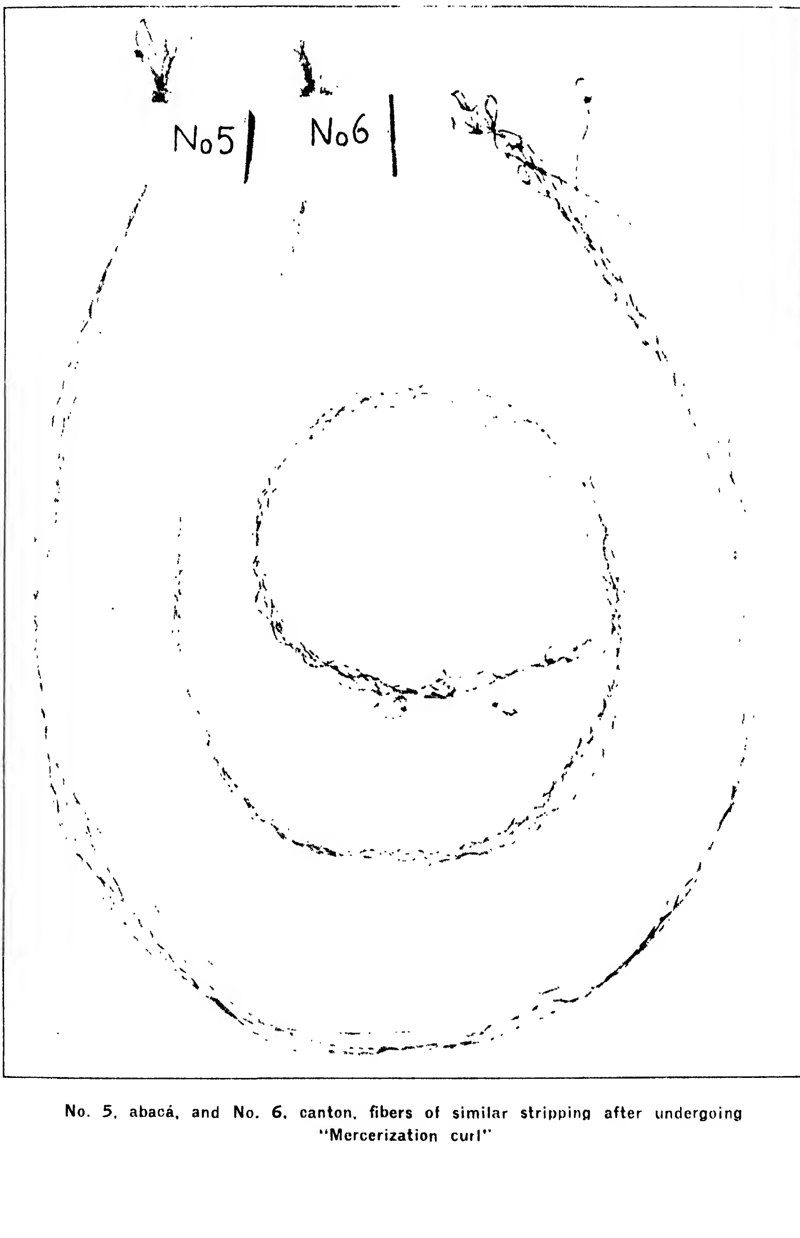
Tube in which the "Mercerization curl" was made



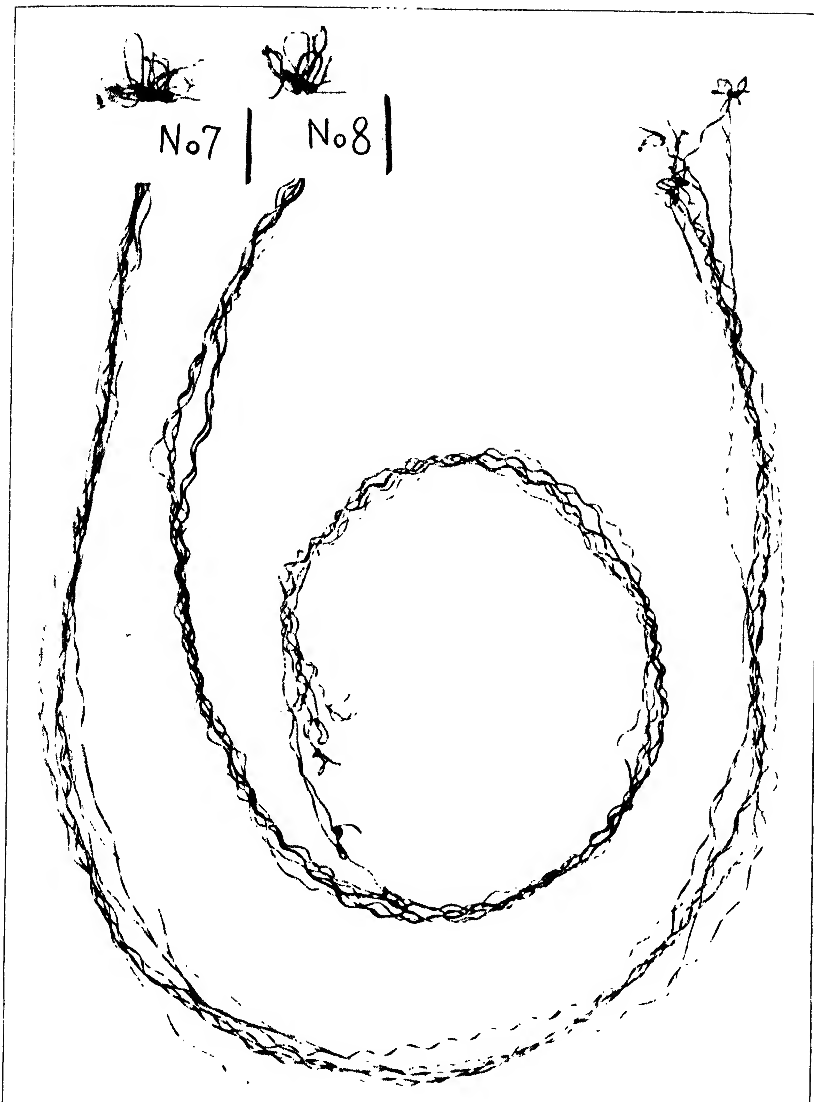
No. 1, abacá, and No. 2, canton, fibers of similar stripping after undergoing the "Mercerization curl"



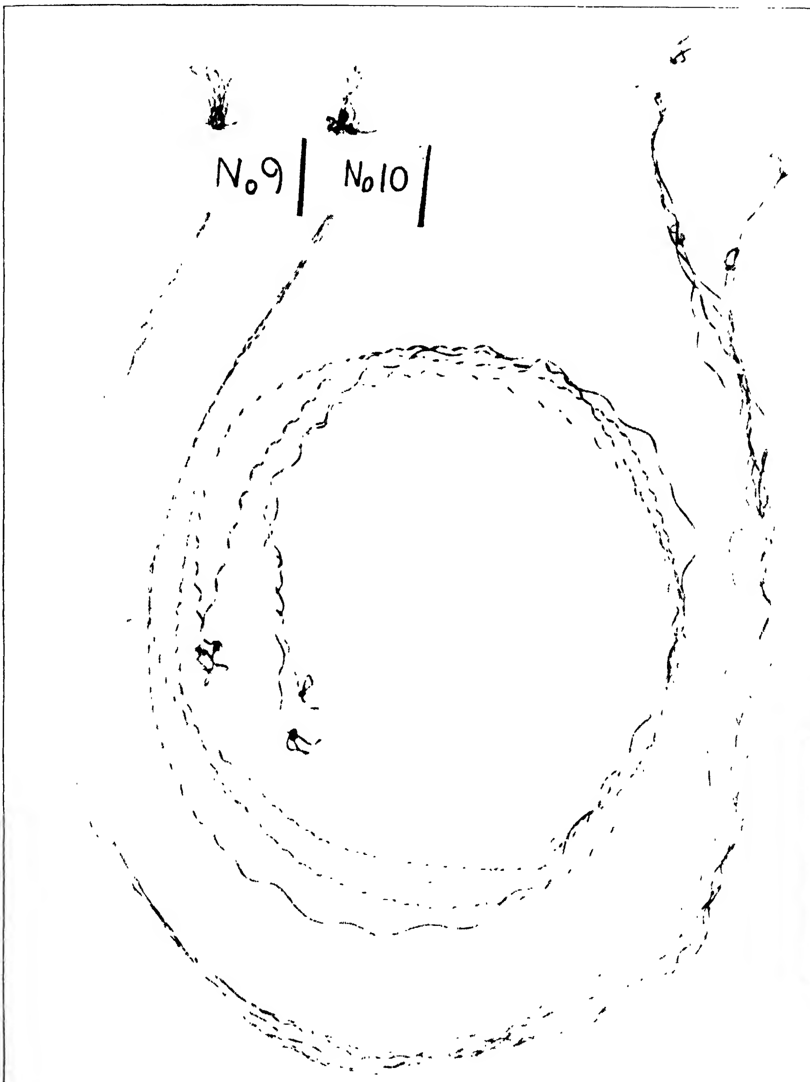
No. 3, abacá, and No. 4, canton, fibers of similar stripping after undergoing the "Mercerization curl"



No. 5, abacá, and No. 6, canton, fibers of similar stripping after undergoing "Mercerization curl"



No. 7, abacá, and No. 8, canton fibers of similar stripping after undergoing "Mercerization curl"



No. 9, abacá, and No. 10, canton, fibers of similar stripping after undergoing "Mercerization curl"

THE GOVERNMENT OF THE PHILIPPINE ISLANDS
DEPARTMENT OF AGRICULTURE AND NATURAL RESOURCES

BUREAU OF PLANT INDUSTRY

MANILA

ADMINISTRATIVE ORDER No. 2

January 13, 1930

Subject: DECLARING THE LEAF MINER BEETLE, *PROMECOTHECA CUMINGII* A DANGEROUS PLANT PEST, AND PROVIDING FOR ITS CONTROL.

WHEREAS, there exists in alarming numbers in the Provinces of Laguna, Batangas, and Tayabas an insect known as the leaf miner beetle, *Promecotheca cumingii*, which disastrously attacks the coconut trees;

WHEREAS, coconuts are one of the main economic plants of the Philippine Islands, the exports of the products amounting to ₱70,000,000 annually;

WHEREAS, adequate measures must be adopted to check the increase, prevent the spread, and so effect the control of this dangerous insect;

Now, therefore, under authority conferred upon the undersigned by section 1757 of Act No. 2711, known as the Administrative Code, and section 10 of Act No. 3027, entitled "An Act to protect the agricultural industries of the Philippine Islands from injurious plant pests and diseases, etc.," the leaf miner beetle, *Promecotheca cumingii*, is hereby declared a dangerous plant pest, and the following regulations are promulgated to govern the removal or treatment of the affected parts of coconut trees, and to check the increase, prevent the spread, and so effect the control of this plant pest:

1. For the purpose of this Administrative Order, all the municipalities in the Provinces of Laguna, Batangas, and Tayabas where leaf miner beetles are or have been known to exist shall be considered as formally declared infested with this plant pest.

2. Whenever the leaf miner beetle is known to exist in alarming numbers in any locality in the Philippine Islands, aside from the municipalities and provinces referred to in this Ad-

ministrative Order, the Director of Plant Industry will send a written report to the governor of the province concerned, either direct or through a plant inspector of the Bureau of Plant Industry, containing, among other things, the names of the municipalities or barrios infested by the plant pest, and the owners or persons in charge of the affected coconut plantations.

3. Upon being notified in accordance with the preceding paragraph, the provincial governor shall immediately inform each municipal president concerned in writing of the contents of the notification of the Director of Plant Industry. The municipal president shall then issue a general written notification to the inhabitants of the municipality to the effect that leaf miner beetles in alarming numbers exist in the municipality, and at the same time declare the municipality infested with this plant pest. Copies of the general notification shall be posted in at least six conspicuous places in the municipality and a certified copy of same sent to the Director of Plant Industry.

4. Once a municipality or a portion thereof has been declared infested with this plant pest, it shall be the duty of the person who owns or has under his charge coconut trees within the infested areas to do as follows:

(*a*) He shall collect or catch, or cause to be collected or caught, the leaf miner beetles, preferably with nets early in the morning from 6 to 9.30 o'clock, for the insects can be seen in flight under the coconut trees during these hours of the day. Those caught are to be killed or otherwise destroyed.

(*b*) In case collecting or catching cannot be done effectively in his particular grove for any reason, he shall spray the beetles with soap solution at the rate of ¼ to ½ pound, preferably with Chinese yellow laundry soap, dissolved in about 18 liters or about one petroleum canfull of water. The spray may be made more effective by using nicotine sulphate or tobacco decoctions and calcium or lead arsenate with the soap. Or he may use calcium or lead arsenate and water alone with some adhesives other than soap. The spray should be directed to the lower surface of the leaves where the beetles are found in considerable numbers. The spraying should be done in such a way as to strike the insects with the liquid so as to wet them and kill them by suffocation.

(*c*) If he is an owner or in charge of at least fifty coconut trees, he shall, aside from the methods prescribed in section (*a*) and (*b*) of this paragraph, dig holes about 1 cu. m. of ground for every 50 trees attacked and place infested coconut leaves in the holes, covering the opening of said holes with 16 wire mesh gauze. The infested leaves must be changed at least every ten days. The idea is to liberate the parasites without allowing the beetles to escape.

(*d*) He shall coöperate with and aid the plant inspectors and other officials of the Bureau of Plant Industry in their work of controlling the leaf miner beetle, and comply with all the instructions, orders, or requirements relative to the destruction or control of this plant pest, such as the systematic destruction of badly infested leaflets or leaves or of entire trees, if thought necessary.

5. In order to carry out the provisions of this Administrative Order, the Secretary of Agriculture and Natural Resources and the Director of Plant Industry or their duly authorized representatives, the provincial governor or his duly authorized representatives, the president of the municipality concerned or his duly authorized representatives, and all other officials connected with or taking part in the campaign of controlling this plant pest, shall at all times have access to or upon any land, lot, yard, garden or plantation of coconut trees where leaf miner beetles in alarming numbers are known or suspected to exist.

6. Nothing in this Order shall be construed or interpreted as prohibiting the Secretary of Agriculture and Natural Resources, the Director of Plant Industry or their duly authorized representatives from permitting the cutting down, taking away or removing, in exceptional cases, in such manner or by such method or under such conditions as may be prescribed by him, of such coconut plants or parts thereof from any or all of the provinces mentioned above, or from those which may be declared infested hereafter.

7. Whenever a municipality or province has been officially declared infested with this plant pest in accordance with paragraphs 2 and 3 of this Order, and in order to promptly effect the control of this plant pest, the Chief of Constabulary and the provincial and municipal officials will be requested, pursuant to Section 12 of Act No. 3027, to assist and coöperate with the Director of Plant Industry in the strict enforcement of all Administrative Orders or instructions of the Director of Plant Industry relative to this plant pest.

8. Any person who, without lawful authority to do so, contravenes or violates any of the provisions of this Administrative Order, or who obstructs or impedes or assists in obstructing or impeding the Secretary of Agriculture and Natural Resources, the Director of Plant Industry or their duly authorized representatives, the provincial governor or his duly authorized representatives, the municipal president or his duly authorized

representatives, or any other official or employee connected with or taking part in the campaign of controlling this plant pest, in the execution of any of the provisions of this Order, shall be liable to prosecution, and upon conviction shall suffer the penalty provided in Section 2746 of Act No. 2711 (Administrative Code), which is a fine not exceeding two hundred pesos, or imprisonment not exceeding thirty days, or both, in the discretion of the court.

9. This Administrative Order shall take effect on January 16, 1930.

(Sgd.) MANUEL L. ROXAS
Director of Plant Industry

Approved: January 16, 1930

(Sgd.) RAF. R. ALUNAN
Secretary of Agriculture and Natural Resources

Concurred in:

(Sgd.) HONORIO VENTURA
Secretary of the Interior

EIGHTH PHILIPPINE LEGISLATURE } H. No. 2307
Second Session }

[No. 3639]

AN ACT CREATING THE BUREAU OF ANIMAL INDUSTRY; DEFINING ITS POWERS AND FUNCTIONS; PROVIDING FOR ITS PERSONNEL; MAKING APPROPRIATIONS FOR ITS ORGANIZATION AND OPERATION; CHANGING THE NAME OF THE BUREAU OF AGRICULTURE TO BUREAU OF PLANT INDUSTRY; AND FOR OTHER PURPOSES.

Be it enacted by the Senate and House of Representatives of the Philippines in Legislature assembled and by the authority of the same:

SECTIO 1. *Creation of the Bureau of Animal Industry.*—There is hereby created under the Department of Agriculture and Natural Resources an office to be known as the Bureau of Animal Industry.

SEC. 2. *Chief officials of the Bureau of Animal Industry.*—The Bureau of Animal Industry shall have one chief and one assistant chief, to be known respectively as the Director of Animal Industry and the Assistant Director of Animal Industry. The Director of Animal Industry and the Assistant Director of Animal Industry shall be either a competent veterinary surgeon or a man well trained in animal husbandry. They shall receive compensation at the rates of seven thousand two hundred and six thousand pesos per annum, respectively: *Provided,* That should any person now in the service of the Government of the Philippine Islands receiving a rate of compensation higher than the amount herein authorized be appointed the first director of the Bureau of Animal Industry, the salary of such director shall be equal to the total remuneration now being received by him for services rendered in one or more governmental entities: *Provided, however,* That the said rate of salary shall not exceed twelve thousand pesos per annum and shall be in effect only as long as the said director remains in office.

Subject to the general supervision and control of the Secretary of Agriculture and Natural Resources, the Director of Animal Industry shall possess the powers generally conferred upon bureau chiefs.

SEC. 3. *Functions of the Bureau of Animal Industry.*—The Bureau of Animal Industry shall investigate, study and report upon the condition of the domestic animals in the Philippine Islands, their improved methods of reproduction and care, inquire into and report the causes of dangerous communicable diseases among them, and the means for the prevention and cure of the same; and in general, to promote the development of the livestock industry of the country, as follows:

(*a*) By the introductoin of improved or purebred domestic animals for breeding purposes, and the improvement of the quality of the breeds or types of domestic animals now found in the Islands;

(*b*) By the control and eradication of dangerous communicable diseases of domestic animals;

(*c*) By conducting a system of demonstration and extension work and encouraging fairs and exhibitions to promote the livestock industry;

(*d*) By the collection and compilation of statistics on domestic animals;

(*e*) By the dissemination of useful information on all essential matters regarding domestic animals through the publication and distribution of bulletins, circulars, and other printed matter and through such other means or agencies as may be deemed effective; and

(*f*) By taking such steps, adopting such measures and promulgating such rules and regulations, not inconsistent with the provisions of this Act and subject to the approval of the Secretary of Agriculture and Natural Resources, as may be deemed necessary to promote the livestock industry.

SEC. 4. *Terms defined.*—"Domestic animals," as herein used, includes horses, mules, asses, cattles, carabaos, hogs, sheep, goats, dogs, deer, fowls, and circus animals or those intended to be used for show purposes.

"Dangerous communicable diseases," as herein used, includes glanders or farcy, surra, anthrax, rinderpest, hemorrhagic septicemia, hog cholera, foot-and-mouth disease, contagious pleuropneumonia, hydrophobia, Europeau fowl pest, fowl cholera, fowl typhoid, or any other acute communicable disease which may

cause a mortality of over five per centum in the period of one month.

SEC. 5. *Animal quarantine, inspection and importation, rinderpest vaccine, powers and duties of the Director of Animal Industry.*—The powers, functions, and duties vested in the Bureau of Agriculture by virtue of section seventeen hundred and sixty-two, "Bringing of animals imported from foreign countries into the Philippine Islands"; seventeen hundred and sixty-three, "Removal of diseased animal from province to province prohibited"; seventeen hundred and sixty-four, "Regulation concerning removal of diseased animals from infected localities"; seventeen hundred and sixty-five, "Powers of Director of Agriculture relative to animal quarantine, inspection, and sanitation"; seventeen hundred and sixty-six, "Delivery of diseased animal to place of quarantine"; seventeen hundred and sixty-seven, "Disposition of body of animal dying of rinderpest"; seventeen hundred and sixty-eight, "Unlawful disposition of parts of animal dying of rinderpest"; seventeen hundred and sixty-nine, "Marking of cattle affiicted with surra"; seventeen hundred and seventy, "Prohibition against bringing of animals from infected foreign countries," of the Revised Administrative Code of nineteen hundred and seventeen; by virtue of Acts Numbered Thirty-one hundred and one, entitled "An Act authorizing the Director of Agriculture, subject to the approval of the Secretary of Agriculture and Natural Resources to promulgate regulations for the preparation, sale, traffic in, shipment, and importation of viruses, serums, toxins, or analogous products used for the treatment of domestic animals," and Thirty-one hundred and sixty-six, entitled "An Act providing for the use of rinderpest vaccine in the control of rinderpest and other contagious and infectious cattle diseases, appropriates the sum of one hundred thousand pesos, and for other purposes, and of such other acts or parts of acts wherein the intervention of the Bureau of Agriculture is required expressly, or impliedly, in matters concerning domestic animals or their diseases, are hereby transferred to and vested in the Bureau of Animal Industry.

SEC. 6. *Stock farms, slaughterhouses, and breeding stations.*—In such places in the Philippine Islands as may be considered suitable for the purpose, the Director of Animal Industry, with the approval of the Secretary of Agriculture and Natural Resources, shall as funds become available therefor, establish, equip, maintain, and operate stock farms, slaughterhouses and breeding

stations to produce and develop superior types of domestic animals adapted to local conditions and needs.

SEC. 7. *Transfer of certain divisions to Bureau of Animal Industry.*—The division of animal industry, comprising the veterinary section, the animal husbandry section, the animal quarantine stations, the Veterinary Research Laboratory, and the stock farms, of the Bureau of Agriculture; the stock farms established under Act Numbered Twenty-seven hundred and fifty-eight and the appropriations therefor and all other governmental agencies connected with these activities, together with their personnel, equipment, implements, materials, properties and other complementary effects, are hereby transferred to the Bureau of Animal Industry. The Director of Animal Industry shall, subject to the approval of the Secretary of Agriculture and Natural Resources, reorganize these activities into such divisions, or sections as will insure the simplest organization and maximum efficiency, and create such other divisions or sections together with the positions required therein, as may be deemed necessary for the proper functioning of the said Bureau: *Provided,* That the Secretary of Agriculture and Natural Resources, may, in the interest of the service, or for reasons of economy, or due to lack of funds, transfer such positions with their respective appropriations, from the administrative, clerical, or other non-technical force of the Bureau of Agriculture to the Bureau of Animal Industry as may be urgently needed by the said Bureau of Animal Industry.

SEC. 8. *Bureau of Plant Industry.*—The different divisions, subdivisions, sections, experimental stations, etc. of the Bureau of Agriculture and all activities or agencies connected therewith which have not been transferred by virtue of this Act to the Bureau of Animal Industry shall, collectively, constitute and be known as the Bureau of Plant Industry. The powers, functions, ex officio positions and duties vested by law or executive order in the Director of Agriculture and the Bureau of Agriculture which have not been transferred to the Bureau of Animal Industry, are hereby vested in and are to be performed by the Director of Plant Industry and the Bureau of Plant Industry. The chief and assistant chief of the said Bureau shall be known respectively as the Director of Plant Industry and Assistant Director of Plant Industry and shall receive the same compensation as that heretofore authorized for the Director and Assistant Director of Agriculture: *Provided,* That the Director of

Plant Industry shall not be paid any additional compensation for services he may render in any governmental entities.

SEC. 9. There is hereby appropriated, out of any funds in the Insular Treasury not otherwise appropriated, the sum of twenty thousand pesos which, together with the funds appropriated in the General Appropriation Act for nineteen hundred and thirty for the division of animal industry and the other activities transferred by this Act from the Bureau of Agriculture to the Bureau of Animal Industry, shall be available for the payment of salaries of the personnel; traveling expenses of personnel; freight, express and delivery service postal, telegraph, telephone and cable service; illumination and power service; rental of buildings and grounds; consumption of supplies and materials; printing and binding reports, documents and publications; contributions and gratuities; and other services: *Provided*, That the special appropriations made in the said General Appropriation Act for nineteen hundred and thirty shall be devoted exclusively to the purposes for which they were appropriated: *Provided, further*, That the Secretary of Agriculture and Natural Resources shall apportion between the Bureau of Animal Industry and the Bureau of Plant Industry for appropriations made for salaries and wages for temporary and emergency employees including laborer, and sundry expenses of the Bureau of Agriculture in the General Appropriation Act for nineteen hundred and thirty.

SEC. 10. All acts or parts of acts insconsistent with the provisions of this Act are hereby amended or repealed accordingly.

SEC. 11. This Act shall take effect on January first, nineteen hundred and thirty.

Approved, December 7, 1929.

The Philippine Journal of Agriculture

[Formerly THE PHILIPPINE AGRICULTURAL REVIEW]

VOL. I SECOND QUARTER, 1930 No. 2

THE COCONUT LEAF-MINER INFESTATION OF LAGUNA, BATANGAS, AND TAYABAS[1]

By VICENTE C. ALDABA, Ph. D.
Of the Bureau of Science

TWO TEXT FIGURES

The present outbreak of coconut leaf miners which have already infested the Provinces of Laguna, Batangas, and Tayabas has apparently changed the idea of many present and prospective planters that the coconut is a crop that offers a sure promise of good profit. That with such an immense area as is now planted to coconuts in the Philippines the planters will always have to be on guard against any pest or disease outbreak is true enough, but once the present extraordinary leaf-miner infestation is put down, the insect should not hereafter become a source of serious loss to the coconut industry. This is the conclusion reached by the present writer after studying the nature of the spread of the leaf-miner infestation.

THE LEAF MINER, *PROMECOTHECA* Spp. AS COCONUT PESTS

Leaf miners in other countries.—In other countries leaf miners of different species are serious pests of the coconut. In the New Hebrides, *Promecotheca opacicollis*, Gestro, is considered the most injurious insect that ever appeared in the coconut plantations. In New Guinea, New Britain, and the Solomon Islands, *P. antiqua*, Weisé is the species which has done considerable damage, while in Fiji it is the *P. coeruleipennis*, Blanchard.

The Philippine coconut leaf miner.—The Philippine leaf miner is *P. comingii*, Baly, and this species is known so far only in

[1] Prepared in coöperation with the Bureau of Plant Industry and released for publication May 15, 1930.

Borneo, the Federated Malay States, and the Philippines. It is always present in many coconut groves here but usually only a few leaflets of far distant trees are infested. Many times, going through a coconut grove, a person may not see a single specimen.

The best place to locate a leaf-miner infestation is in townsites and other dwelling centers where coconuts are growing. Here evidently, conditions are favorable for the multiplication of the leaf-miner beetle. Often trees with all the leaves attacked by both the adults and the larvae may be seen. Many of the reported leaf-miner infestations from other towns in the Philippines are of this kind.

THE INFESTATION OF LAGUNA, BATANGAS, AND TAYABAS

Extent of infestation.—The present infestation covers an area in which are included coconut trees that probably number some 7,000,000. Practically all of these trees are suffering from leaf-miner attack. Few people seem able to realize that there is such a tremendous number of infested trees, especially among those who have not had an opportunity to observe the whole infested area closely. It is true that the leaf-miner, *Promecotheca cumingii*, Baly, is an endemic pest in the Philippines and is, therefore, to be met here and there in coconut groves, but ordinarily this infestation occurs only on a few leaflets of isolated trees. But of the present outbreak it would be safe to state that not five per cent of the trees have escaped attack by the leaf-miner and many groves are so badly attacked that all the fronds of all the trees are withered.

Intensity of infestation according to localities.—Going through the infested region not only by the roads but also through the groves in many directions, it can be observed that the trees standing in open places are the most severely attacked. The coconut palms around dwelling places, alongside the roads, banks of rivers and streams, around the borders of lakes and rice paddies, on hillsides, and in isolated groves stand out conspicuously as more seriously infested than the others. In these places, viewed from a high point, the trees in advanced cases appear to be entirely dry. This variation in intensity of infestation appears to be due to a combination of a number of factors. The adults of this beetle apparently have a habit of flying early in the morning to bask in the rays of the rising sun. Naturally open places give them the best opportunity to follow this inclination. Hence their concentration at these

points. The wind must also have some influence in the gathering of the beetles. They fly sluggishly and naturally wind of any velocity would decide a good deal the direction of their course. Since when flying they are likely to meet heavier winds in open places they would naturally be carried along by them until they could cling to the leaves of the coconuts, and naturally again they are going to set their feet first on trees in the open places. Especially would this be true when the wind strikes a slope, in which case the beetles would naturally seek a foothold on any coconut leaves to be found.

The more serious infestation of coconuts around dwellings may be due also to other causes besides the fact that such places are more open than the other parts of the plantation. Here, usually, bonfires are made in the evening and of course the cooking in the houses in open stoves is also equivalent to building bonfires. It is known that the parasites are greatly attracted by strong light while the leaf-miner beetles are not so much so. It is conceivable that this differences in behavior would result in the greater number of eggs developing into destructive larvae and adults, and hence in greater damage to the trees.

The course of the spread of the infestation.—The area infested maintains a circular form. The map (Fig. 1), shows the circumference of the infested area, which includes all the outermost barrios reported as infested about the end of January, 1930. As has already been stated, practically all the trees within this area are infested with leaf-miner beetles.

All around the border of this infested area is that of the most recent infestation which is of adults. Going from the border back towards San Pablo it can be observed that the infestation is over a year old and in fact a number of years old. Carefully gathered information from apparently intelligent people in places along a line from the border of infestation to San Pablo showed the correctness of the above statement.

But there is other evidence to show that the infestation is older the nearer the place is to San Pablo.

Since the life cycle of the beetles is more or less definite—about two months, or some 54 days according to Jones[2]—the relative age of the infestation in different places may be determined by counting the number of generations. It has been possible to do this by counting the number of larval generations in the recently fallen leaves. The stages of drying of the mined tissues indicate the different generations. The table below shows the observations at points indicated.

TABLE I—*Showing the number of larval generations at different points. Date of observations, from January 28 to February 6, 1930*

Barrio and town	Number of generations	Remarks
Santa Magdalena, San Pablo	3	About 4 kms. NW. of San Pablo.
Santa Isabel (at roadside, San Pablo)	3	About 3.5 kms. NE. of San Pablo.
Santa Isabel (outside boundary) San Pablo)	2	About 5.5 kms. NE. of San Pablo.
San Lorenso, San Pablo	2	About 5.5 kms. N. of San Pablo.
Santisimo Rosario, San Pablo	2	About 8 kms. S. of San Pablo.
San Cristobal, San Pablo	2	About 7 kms. SE. of San Pablo.
Caragatan, Dolores	2	About 9.5 kms. SE. of San Pablo.
San Gregorio, Alaminos	2	About 8 kms. SW of San Pablo.
Santa Maria, San Pablo	2	About 5.5 kms. S. of San Pablo.
Santa Cruz, San Pablo	2	About 6 kms. SE. of San Pablo.
Malabanban, Candelaria	1	About 21 kms. SE. of San Pablo.
Anos, Los Baños	1	About 16 kms. NW. of San Pablo.

The number of generations in the oldest infested area, that is at the town center of San Pablo, has not been determined, since it has not been possible to count more than three generations in a single leaf. This is due to the fact that in an ordinary attack, by the third generation the leaves are already old enough to fall.

There is another line of evidence to show that the infestation is older the nearer the place is to San Pablo. By studying the curves of the number of nuts actually on the trees from different places and comparing them with the normal curve of the nuts on unattacked or recently attacked trees, the comparative age of infestation may be determined.

The following table shows the number of nuts on the fruiting branches of trees from different localities:

TABLE 2.—*Showing the average number of nuts on each fruiting branch, from the oldest to the youngest, of trees at different distances from San Pablo. Observations made from February 6 to 11, 1930.*

Locality	No. Ave.	1	2	3	4	5	6	7
Candelaria, normal	10	3.0	3.8	3.0	3.6	2.9	3.6	3.2
Poblacion, San Pablo, near the Franklin Baker & Co. factory	8	6/8	3/8	4/8	1/8	2/8	0	3/8
Santa Magdalena, 4 kms. NW. of San Pablo	5	2.8	2.2	1/8	.3/6	2/6	2/2	2/8
San Ignacio, about 4 kms. SE of San Pablo	5	2.4	1.6	1.8	2.0	1.2	1.0	.6

Locality	No. Ave.	8	9	10	11	12	13	14
Candelaria, normal	10	4.1	4.6	4.9	3.0	3.1	5	5
Poblacion, San Pablo, near the Franklin Baker & Co. factory	8	6.8	0	0	0	------	------	------
Santa Magdalena, 4 kms. NW of San Pablo	5	2.6	2.0	2.4	.8	.6	------	------
San Ignacio, about 4 kms. SE. of San Pablo	5	1.6	.8	.2	.2	0	------	------

The data in the table were plotted to show graphically the date when the number of nuts began to decrease. (See Fig. 2).

In order to make the curves more smooth, each two consecutive averages are combined. Since one fruiting branch appears every month, each point in the curves represents the nuts on two consecutive bunches. The general practice is to gather nuts every two months, so the first point in the curve represents the nuts ready for harvesting in February, the second in April, the third in June, etc.

It can be seen that the curve from Candelaria runs nearly flat from January to June, then rises until October. The curve

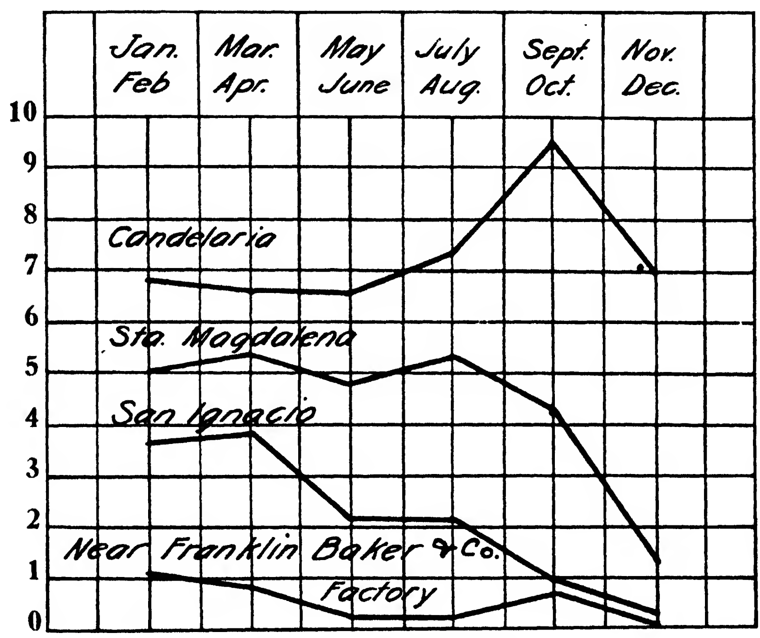


FIG. 2. For explanation see text.

from near the Franklin Baker & Co. factory shows by the number of nuts represented that the trees have been suffering since before January. Many trees have no nuts. The curves from Santa Magdalena and San Ignacio show that there has been a reduction in the yield of nuts from about April.

NATURAL ENEMIES

In coconut plantations where leaf miners are found only occasionally, they may be seen to be damaging only a few leaflets of a tree. Usually the middle-aged leaves are first attacked and

in the leaf which happens to be infested the leaflets that are usually adjacent to each other. It may readily be observed that many larval attacks, as shown by the length of the mined tissues do not progress very far and for some reason or other the larvae die before they reach the adult stage. Many eggs evidently do not hatch. To some extent parasites kill the larvae and the eggs. In these ways the leaf-miner is ordinarily controlled in plantations.

TABLE 3.—*Showing the prospect leaf-miner eggs have of developing into adults. Observation made of ten adjacent leaflets at the middle of one leaf picked at random, March 6, 1930, Longos, Laguna. The tree is about five years old surrounded by lanzon trees (Lansium domesticum), arenga and other coconut palms. One adult was captured in one of the leaflets.*

Number of leaflets	Number of eggs	Number of eggs hatched into larvae	Number of eggs parasitized as shown by exit holes of parasites	Number of larvae which developed into adults	Number of larvae parasitized as shown by exit holes of the parasites	Longest mined tissue	Remarks
						cm.	
1	9	2	4	0	0	10	
2	15	5	4	0	Exit holes uncertain because part of epidermis enclosing the mine is gone.	1.2	
3	10	2	2	0	All epidermal coverings of the mines except one are broken and this has no exit hole.	1.3	
4	11	1	1	0	Exit hole uncertain; epidermal covering of mine being broken.	1.3	
5	7	4	1	0	One exit hole through epidermis of longest mine.	2.7	
6	3	0	0	0			
7	13	3	1	0		1.8	Two larval attacks aborted at very early stage.
8	11	1	2	0		3.4	
9	7	1	1	0	Exit hole uncertain; epidermal covering of mines being broken.	2.1	One egg parasitized with 6 exit holes.
10	6	2	1	0 or 1	Covering of longest mine being broken so determination of exit hole uncertain.	10.5	Covering of longest mine is broken; exit hole of larva cannot be determined; so whether it developed into adult is uncertain.
Total	92	21	17	0 or 1			
Per centage	100	22.8	18.4	0 or 0.9			

Eggs unaccounted for .58.8%

Parasites.—The foregoing shows that the parasites play an important rôle in keeping down the number of the leaf-miner beetles, although there are other factors. Jones(2) found that there are two hymenopterous parasites—one of the egg and the other of the larva. The staff of the leaf-miner campaign of the Bureau of Plant Industry in San Pablo have found six kinds of parasites—two for the egg, and four for the larva.

The life cycle of the leaf miner is about 54 days, while that of the egg parasites is about 23 days. There are therefore at least two broods of these parasites possible to one of the leaf miner. Hence, it is believed that if the egg parasites are given full opportunity to multiply they can keep down the ravages of the beetles, provided both have an equal start in numbers. In addition to this fact of a shorter life cycle, it seems also that the egg parasites are polyembryonic, that is, a number of adults may develop from a single egg. As an evidence of this, as many as five parasites have been found in one egg of the leaf miner. However, nothing is as yet known as to the relative length of the lives of the egg parasites and the leaf miner and the number of eggs laid by the former in a lifetime.

The definite length of the life cycles of the larval parasites is also not yet known, although it seems certain that it cannot be more than the combined days of the larval and pupal stages, which are respectively, according to Jones(2), 32 and 7.5 days. It is also strongly suspected that the larval parasites are polyembryonic, for as many as 35 of one kind have been counted in one leaf-miner larva.

Considering the facts that the life cycle of each kind of parasites is shorter than that of the leaf miner, and that the parasites are polyembryonic (at least it appears to be so), there are good reasons to believe that, under natural conditions, the parasites should be able to keep the number of the beetles down to a harmless minimum.

The rôle of the falling off of old leaves of the coconut trees in controlling the leaf miner.—In coconut groves where the leaf-miner infestation is not so serious, it can usually be seen that the larval attacks are more numerous on older leaves and that ordinarily the attack starts from about the middle leaves and goes downward. Upon close examination it will be discovered that there are two or three generations of larvae, as indicated by the stages of dryness of the epidermis covering mined leaf tissue. It can also be seen that there are more of the later generation than the earlier and that the apparent more serious

attack on the old leaves is due to the combined mined tissues made by two or three generations of larvae.

TABLE 4.—*Showing the number of the larval generations on each leaflet and the number of larval attack in each generation. Sta. Magdalena, January 24, 1930.*

Number of leaflets	Number of larval attacks, first generation	Number of larval attacks, second generation	Number of larval attacks, third generation	Remarks
1	1	2	4	
2	0	1	1	
3	1	2	7	
4	0	0	6	Part of leaflet gone.
5	1	3	3	
6	1	2	0	½ leaflet gone.
7	0	4	4	
8	1	3	2	
Total	5	17	27	
Average	5/8	2 1/8	3 3/8	
Percentage	10.2	34.7	55.1	

For some reason or other the leaf miner prefers to lay its eggs on the older leaves.

The table also shows that there are more larval attacks in the later generations. It may be assumed, therefore, that more eggs are also laid in the later generations. These eggs are not laid at the same time. It has been observed that a leaf-miner beetle lays several dozen eggs in a lifetime and that an egg is laid every day although there are days when no egg is laid and days when there are two or more. It may be inferred, therefore, that when the leaves naturally dry up and fall, a number of the eggs remain unhatched. As to the larvae, since they take about 32 days to reach the pupal stage a large proportion will naturally fail to develop fully if the eggs are hatched when the leaves are old and about to fall. The observations in the following table are full of interest on this account.

TABLE 5.—*Showing number of eggs laid, eggs parasitized, eggs hatched into larvae and eggs unhatched in old fallen leaves. Observations made in Magdalena, about 4 kilometers from San Pablo, January 24, 1930.*

Number of leaves	Total number of eggs	Number of eggs parasitized	Number of eggs hatched into larvae	Number of eggs unhatched	Larvae which failed to developed into adults
1	44	11	7	26	0
2	38	7	6	25	0
3	22	5	9	8	2
4	16	3	6	7	3
5	34	8	7	19	3
6	7	1	3	3	0
7	24	3	8	13	6
8	14	7	6	1	0
Total	199	45	52	102	14
Percentage	100	22.6	26.1	51.3	26.9

The number and activities of adults as controlling factors.—In seriously attacked groves all the leaves are perfectly dry. They appear silvery grayish, viewed from above, especially when they are exposed to the sunlight. Close examination shows that the attack consists in the making of very numerous parallel grooves. These are very narrow, being only a fraction of a millimeter in width, and virtually all on the undersurface of the leaflets. They mark the course of the feeding of the adults.

In the early stage the leaflets appear green, the dried tissue being limited to these grooves made by the adults. But drying soon takes place, starting at the end of each leaflet and progressing downward. In the advanced stage all the leaflets are dry, and there are a larger number of fruiting bodies of a kind of fungus (*Pestalozzia palmarum*). The lustrous silvery appearance is apparently due to the presence of the mycelium of this fungus. Thus the drying of the leaves is hastened by the later invasion of at least one kind of fungus. The effect of this drying on the next generation of beetles is shown very well in the following table.

TABLE 6.—*Showing observations made in Dayap, barrio of Pila, on February 19, 1930. Average length of leaflets about 60 centimeters. All leaflets are dry.*

Number of leaflets	Number of eggs	Number of eggs parasitized	Number of eggs hatched into larvae	Eggs unaccounted for	Remarks
	75	13	23	39	2 parasites emerged at upper surface of leaflet. All larvae limited to the basal half of the leaflet.
	114	19	22	73	5 eggs laid in upper side of leaflet. Larvae mostly near basal part.
	56	13	4	39	2 eggs laid on upper surface. Longest mine 2 cm. All limited at basal half.
	111	16	36	59	Larval attack mostly at base; longest mine 3 cm.; 6 larvae parasitized as shown by exit holes.
Total	356	61	85	210	
Average	89	15¼	21¼	52½	
Percentage		17.1	23.9	59.9	

The tables shows in a very emphatic manner how very numerous beetles will prevent their own further multiplication. During the rapid drying of the leaves only a few hatched into larvae and these were limited to the basal part of the leaflets. At the end where the drying up begins, no egg was hatched at

all and in all cases no larva developed to full size, the longest larval attack being only about 3 centimeters.

The length of time it takes for a new leaf to appear, which is about a month, makes this natural control the more effective; and if no fresh coconut trees are available, the adults themselves may be starved. It may be added in passing that the drying of the leaves means so much injury to the tree that the next leaf is not only delayed in coming out but fails to develop fully. In fact, in a seriously infested grove visited by the writer, only about one-third of a leaf emerged from each tree and there were present literally hundreds of beetles cutting numerous grooves which will doubtless result in the further limitation of the food materials of the pest. If the beetles would remain in the grove and all green parts were attacked as soon as they emerged, the death of the trees might be expected.

The rôle of birds and other predators.—There has been a good deal said in the local press about the usefulness of birds in keeping down insect pests and no doubt some of them at least, are preying on the leaf-miner adults. When the subject of predators is carefully looked into it will doubtless be discovered that there are a large number of them of varying degrees of usefulness.

Other undetermined factors.—There are other factors the combined effect of which in limiting the number of the coconut leaf-miner beetles under ordinary conditions appears to be more than all the factors already enumerated. Thus in Table 6 only 18.4 per cent of the eggs are parasitized and 22.8 per cent hatched into larvae. The remaining 58.8 per cent are unaccounted for and a large number of these eggs are already old and doubtless dead. Of the 21 larvae, not one developed into an adult or at most not more than one and only one larva was determined with certainty to be parasitized.

BIOLOGICAL BALANCE UNDER NATURAL CONDITIONS

From what has been said of the natural enemies of the coconut leaf miner, it will be easy to understand that under natural conditions the leaf-miner infestation is prevented from assuming serious proportions. Any increase in the number of the beetles would be accompanied by an increase in the number of each kind of parasites. The attention of the predators would be attracted towards the presence of an extraordinary amount

of beetle food and it would increase their activity in that direction. The other undetermined factors would certainly exact a proportional toll.

Should the leaf miners multiply so rapidly as to overwhelm their natural enemies, their own number would prevent further multiplication; and since, under natural conditions, the coconut and other palms which serve as food for the leaf miners do not grow exclusively together to any extent, the final destruction of the leaf miners themselves would be the inevitable result. Very likely the process would not go so far; but as soon as the leaf miners had been reduced to a harmless minimum the growth of the attacked trees would be resumed until the old conditions were practically restored. In this way the so-called biological balance would be maintained with respect to the leaf-miner and its enemies.

THE RAPID SPREAD OF THE INFESTATION

The question now is, Why has this coconut leaf-miner beetle been able to multiply to such an enormous extent as to cause such tremendous devastation in the coconut groves of Laguna, Batangas, and Tayabas?

Different theories.—The immediate answer of those who were, by circumstances, called upon to make an explanation, is the disturbance of the biological balance. With this as a starting point an explanation was to be sought for the cause of the disturbance. Naturally, since the supposed balance is between the coconut leaf-miner beetles on the one side and the parasites on the other, a preponderance in the number of one must be due to a reduction in the number of the other. A diminution in the number of parasites is logically the answer. The next step is to look for some factors which may explain the supposed decrease in the number of parasites. Thus, the storms and the rains have been overworked to explain the hypothetical diminution in the number of parasites. Other factors also there are which have been supposed also to be causes of the decrease in the number of parasites. There is a fundamental defect in this assumption that the parasites have decreased in number, and that is that it presupposes their former existence in a large number. The number of parasites is evidently conditioned by the number of leaf-miner beetles. Ordinarily, in coconut plan-

tations the beetles are rare and necessarily the parasites must also be rare. There is therefore no reason for supposing that there has been a decrease in the number of parasites. Indeed all the numerous data gathered by the leaf-miner campaign office in San Pablo show that there has been an increase in the number of both the beetles and the parasites.

A statement has been made to the effect that the coconut leaf-miner beetle being a well-established pest and therefore having its own specific parasites cannot possibly ravage the coconut groves. It is pointed out that any conspicuous infestation is only due to a temporary disturbance of the biological balance, the restoration of which may be expected to take place quickly so that its disturbance need not cause any alarm. It is even insisted upon that nothing should be done in the way of control, except to wait for the natural enemies to overcome the beetles, which theory is only a more comprehensive edition of the former one which is premised on the decrease of the parasites alone.

There are two sides to this question, the one practical and the other theoretical. When this idea was given publicity, about four million (4,000,000) coconut trees were already infested and a large number of them so badly that all or a large number of their leaves were dry. Even if ultimately the parasites and other natural enemies of the leaf miner may keep down the infestation, still in the face of such tremendous damage as has already been done by the pest, it becomes the duty of every man concerned to do all he possibly can towards its suppression.

Concerning the second side, it should be stated that as soon as a forest has been cleared and become planted to coconuts, the biological balance has been disturbed and will remain disturbed as long as the old conditions are not restored. In other words, conditions in the coconut regions of Laguna, Tayabas, and Batangas now are not natural. It is therefore futile to speak of or imply a temporary disturbance of biological balance in connection with the present infestation of the coconuts by the leaf miner, and the theories which have been mentioned and given so much publicity are in reality not much more than guesses based on a wrong interpretation of a fundamental principle.

While in the foregoing paragraph the subject of biological balance has been considered to be only of academic interest

still the recognition of the fact is of far-reaching practical importance. There are two important problems involved:

First, would it be possible for the parasites alone to put down the present infestation?

Second, is the prevention of a recurrence of such an infestation practically possible?

Distribution and multiplication of parasites in the infested area.—It has already been stated that the rate of multiplication of the parasites depends mainly upon the abundance of the beetles. A study of the extent of parasitism on the eggs and larvae and pupae of leaf-miner beetles shows that it is very uneven in different barrios and even in adjacent groves. Forty-three determinations from January 27 to February 25, showed that egg parasitism varies from nothing to 71 per cent and larval and pupal parasitism from nothing to 80 per cent. The average of all determinations is, for egg parasitism, 32 per cent, and for larval and pupal, 31 per cent. Seven per cent of all determination on egg parasitism fall between 0 and 10 per cent; 14 per cent, between 10 and 20 per cent; 37 per cent, between 20 and 30 per cent; 16 per cent, between 30 and 40 per cent; 9 per cent, between 40 and 50 per cent; 7 per cent, between 50 and 60 per cent; 5 per cent, between 60 and 70 per cent; and 5 per cent, between 70 and 80 per cent. Of the larval and pupal parasitism, 32 per cent of all the determinations fall between 0 and 10 per cent; 14 per cent, between 10 and 20 per cent; 14 per cent, between 20 and 30 per cent; 5 per cent, between 30 and 40 per cent; 18 per cent, between 50 and 60 per cent; 5 per cent, between 60 and 70 per cent; and 7 per cent, between 70 and 80 per cent. It thus appears from these figures that the parasites are not overtaking the beetles. It may be stated here in passing that the facts brought out by these figures and recognized by the leaf-miner campaign office is the motive of the policy of distributing the parasites where they are rare.

Parasitism on the border of the infested area.—But there is another side to this question of distribution of parasitism. It has been stated elsewhere that the existence of the parasitism is conditioned by the existence of the leaf-miner. Naturally on the border of an infested area to which the beetle has just migrated, the parasites should be expected to be at the minimum. This expectation is borne out by the observations of the

scouting parties of the leaf-miner campaign. The latest observations are given in the following table:

TABLE 7.—*Showing the percentage of parasitism at or near the border of the infested area*

Barrios	Towns	Date of observation	Percentage of parasitism of eggs	Percentage of parasitism of larvae and pupa
San Roque	Majayjay	February 19	14	4
Banbang	Nagcarlang	February 21	4	0
Panglan	Majayjay	February 20	10	6
Elayang Sugage	Lilio	February 21	0	0

It is plain from the figures given that the prospect of the parasites exterminating the beetles at the border of the infested area is still much less, and as long as fresh coconut trees are available, the outward movement of the pest is assured without much resistance.

How the leaf miner spread to such an extraordinary extent.—This question the writer first attempted to answer in a report informally presented to the Director of Plant Industry on January 8, and formally on January 13. Since that time all observations in the field and laboratory have simply added more evidence pointing towards the correctness of the answer. It is therefore given here again, omitting, however, the parts which would be a conspicuous repetition of what has already been dealt with in this paper.

"After considering all the facts which may be taken as well established in connection with the present outbreak of the leaf-miner beetles, there is one which is outstanding and which furnishes the starting point towards the understanding of the whole situation. *This is the fact that the infestation has been and is spreading radially in all directions with San Pablo as the center.* The coconut groves of Laguna, Tayabas, and Batangas have been established for a number of years and during all this time a temporary biological balance between the leaf-miner beetle and its parasites has been more or less rigidly maintained. The time has come when, with the growth of the town of San Pablo, changes have occurred in the locality which either favored the faster multiplication of the beetles or held down the increase of the parasites, or both simultaneously. There are factors known which affect the leaf-miner beetle and its parasites differently. The electric light is known to attract the parasites but not the beetles. The beetles are known to be

in larger number near lakes, rice paddies, and rivers, while the coconuts near the San Pablo station which are receiving the smoke from train engines are known to have been attacked severely as early as the first months of 1928.

"Whichever of the foregoing considerations may happen to be correct is immaterial for the present. The important fact is that the leaf-miner beetles have increased more than the parasites in this locality, which has become the center of infestation. The increase in the number of the leaf miner beetles was slow at first, the rate being conceivably more or less following the compound interest law or the laws governing autocatalytic reactions. In accordance with the same mathematical rate the tremendous speed of the spread of infestation which has finally attracted public attention should have been expected.

"Once the center of infestation has been established, it is only a question of reaching a ratio between the number of the leaf-miner beetles and of the parasites high enough for the former to overwhelm the latter, and the infestation may be expected to spread all over any solid area covered by coconut trees. It is not necessary to assume that there has been a diminution in the number of parasites for the high ratio between the number of the leaf-miner beetles and the parasites to have taken place; and indeed in the present case all available figures tend to show that there has been an increase in the number of parasites parasitizing the leaf-miner beetles during one or another stage in its life history. The fact may be considered as established, at least in the present case, that while both are increasing in number the beetles increase faster.

"As the leaf-miner beetles attain such numbers that the food material and breeding facilities available in the locality in the form of coconut leaves are no longer sufficient or satisfactory, they move on to the next trees. Naturally only the adults can move to the new home. They at once begin to feed and lay eggs. This can readily be seen in newly attacked trees. Then the parasites begin to work but many eggs escape and develop into larvae. Some larvae are parasitized, but a number develop into pupae and some pupae are also parasitized, but a number finally emerge as adults (Table 4). These adults then lay eggs and therefore add more eggs to the large number that is being continuously laid by the large number of adults which migrated into the place. This process goes on until the available food materials and breeding facilities are no longer sufficient or satisfactory. New migration to the next lot of fresh

coconut trees then takes place and the process is repeated. The parasites parasitizing the leaf miner at one or another stage of its life history have also increased in number on account of the increased supply of leaf-miner beetle eggs, larvae, and pupae, but they have not increased as fast as the beetles. Thus the circumference of the area infested has constantly been increasing.

"It should be added to what is now very well known by the personnel of the leaf-miner campaign, that in the newly infested area the parasites are practically absent. As has been stated elsewhere, this is naturally to be expected, since the increase in the parasite population depends upon the increase in the number of the leaf miners.

"It can readily be seen that there is no reason to expect that the leaf-miner beetles will ever be put down by the parasites in the present infested area as long as the available food and breeding facilities are satisfactory. There are those who claim that it may be expected that the leaf-miner infestation may be put down by the parasites of the beetle unaided by man. That could be expected only under natural conditions and not in an immense coconut grove that has been artificially created.

"Bearing in mind what has already been said concerning the simple mathematical facts responsible for the steady increase of the territory occupied by the leaf-miner beetles, there appear to be only two ways the pest can be stopped from doing further damage to the coconut trees, barring of course unforeseen extraordinary circumstances.

1. The presence of a natural barrier which would prevent the further outward march of the beetle. This barrier would have the form of a gap such as a body of water or a big strip of land not planted to coconuts or other plants which would serve the leaf-miner beetles as a source of satisfactory food materials and a good place to breed.
2. The determined application of all known and available means to reduce the number of the beetles to a harmless minimum.

"In the first case the establishment of the natural barrier would be accomplished only when the large solid coconut plantation grove of Laguna, Tayabas, and Batangas is fully gone over by the beetles. To allow this to happen is of course unquestionably undesirable. But this consideration indicates what should be a most important part of the present campaign to control the beetle. Instead of waiting for a natural barrier, to stop the progress of the pest, an artificial one should be established. This may be done by poisoning all the leaves of all the

coconut trees along the whole border of the infested areas. Other palms such as buri, anahaw and bunga, should also be poisoned if they might serve as a bridge to carry over the leaf-miner beetles to the uninfested area. Since this pest progresses slowly and does not jump a long distance like the locust, for example, to start new infestations in other spots, by poisoning a sufficient number of trees on the border line of the infestation, there would be established a cordon of poisoned trees broad enough to insure the killing of the beetles that feed on the poisoned leaves before they could go through.

"Then the beetles inside the infested area should be dealt with severely by artificially aiding the parasites to increase in number as fast as possible and by destroying by all possible means the beetles in the adult, pupal and larval stages. As soon as the cordon was well established and the beetles were corralled within the cordon of poisoned coconut trees, a factor would come into play which would help tremendously in putting down the infestation, namely, the pest would be deprived of food and breeding places to a very large extent."

There are now five methods which have been found to be effective in reducing the number of the leaf miners and preventing its further spread:

1. Killing the larvae and adults by the people. This is compulsory for able-bodied male citizens of the infested towns.
2. Cutting down and burning heavily infested leaves. Usually the four or five oldest leaves are the most affected.
3. Transporting the parasites from places where they are in abundance to places where they are scarce. The infested leaves which are heavily parasitized are placed in holes in the ground which are covered by a wire screen with mesh of a size that allows the escape of the parasites but not of the beetles, and the rearing of the parasites on a large scale in regularly organized stations and their distribution in places where parasites are rare.
4. Spraying the beetles with contact poison. Ordinary soap is mostly used.
5. Maintaining a cordon of poisoned coconut trees around the infested area. Ordinary soap and calcium arsenate are used. In this case the soap solution is not so much intended for a contact poison as in number four but to make the calcium arsenate stick to the leaves of the coconuts.

IS THE PREVENTION OF THE RECURRENCE OF SUCH AN OUTBREAK OF INFESTATION PRACTICALLY POSSIBLE?

Since the tremendous damage to the coconut that is being caused by the present infestation has become known to the Philippine public, planters have begun to search for leaf miners in their groves. Many cases of infestation have been reported,

mainly from the town centers. It should be plain by now that these centers of infestation are potentially capable of developing an outbreak similar to that of San Pablo. However, the prevention of an outbreak is practically an easy matter if proper steps are taken at the initial stage of the infestation. Since the infestation spreads very slowly at first from a focus and since the beetles do not fly to distant places, as does the locust, for example, on the start of a new infestation, all that is needed is a constant watch, and a determined effort to stamp out the beetles when they appear. This may readily be maintained, since the leaf miners are easily destroyed and their spread prevented by poisoning all the coconut trees surrounding the infested area. Town centers and other dwelling places are likely to serve as foci of infestation and these places would bear watching.

SUMMARY AND CONCLUSIONS

1. There are several species of coconut leaf miners that cause serious injury to the coconuts in different countries. The Philippine species is *Promecotheca cumingii*, Baly. This is always present in coconut groves but usually only a few leaflets of isolated trees are attacked.

2. The present leaf-miner infestation of Laguna, Batangas, and Tayabas affects about 7,000,000 coconut trees. The attack is most severe on trees standing around dwelling places, alongside of the roads, banks of rivers and streams, around the border of lakes and rice paddies on hillsides and in isolated groves.

3. The infestation has been found to have started from coconut trees growing around the town of San Pablo. These trees have been suffering from the attack of leaf miners for a number of years.

4. It has been shown that there are a number of factors that keep down the number of the coconut leaf-miner beetles. Under natural conditions these factors maintain with the leaf-miner beetles a sort of biological balance, keeping the latter from increasing to an extent that would cause serious damage.

5. Since conditions in the coconut groves of Laguna, Batangas, and Tayabas are not natural, there is no reason to expect that the natural enemies of the leaf miner will be able to bring the number back to a harmless figure before the whole coconut area of these provinces is gone over by the pest.

6. It has been shown statistically that even in the old infested area the parasites have not shown themselves able to exterminate the leaf miners, contrary to the opinion entertained by many.

In the newly-infested area the percentage of parasitism is very low; so that the outward movement of the pest is assured without much resistance.

7. It has been shown that in order to explain the present extraordinary leaf-miner outbreak in Laguna, Tayabas, and Batangas, it is not necessary to assume that there has been a decrease, due to some extraordinary conditions, in the leaf-miner parasite population. Indeed, as the numerous figures gathered by the leaf-miner campaign office in San Pablo show, there has been just such a proportional increase in the parasites population as should naturally be expected. The fact that in townsites and other dwelling centers where coconuts trees are growing, leaf-miner infestation of a more serious and more permanent kind occurs is proof in itself that in these localities conditions are more favorable for the more rapid increase in the number of the coconut leaf-miner beetles. It has been explained that once a center of infestation is established, by a process of growth similar in rate to that of the compound interest law or the laws governing autocatalytic reactions, the ratio between the leaf miners and the parasites will in due time become great enough for the pest to exert a pressure, so to speak, sufficient to overcome all resistance by the parasites and other enemies. Then, it may be expected that, unless human interference in the way of control measures is instituted, the pest will cover any solid area of coconuts palms. The present infestation, which has come to cover such a wide area, has been shown to have started in the town site of San Pablo where the infestation has been for some time growing slowly, in accordance with the mathematical rate just cited. Thence, with such a tremendous speed as again should be expected in accordance with the same mathematical rate just mentioned, the infestation spread in all directions maintaining a circular perimeter with San Pablo as center.

8. Considering the nature of the spread of the infestion, the leaf miners should not, hereafter, cause tremendous damage to the coconuts, provided that pains are taken to control the pest

at the initial stage of an outbreak. This is practically an easy matter, since the leaf miners can readily be destroyed and their spread be prevented by poisoning all the trees around the infested area.

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CITRUS GROWING IN THE PHILIPPINES

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SIXTEEN PLATES AND NINETEEN TEXT FIGURES

INTRODUCTION

There is no locality of importance in the Philippines wherein some fine citrus trees may not be seen. Yet the commercial culture of citrus fruits in this country is only carried on in a small scale and under primitive methods, although it is highly probable that citrus fruit growing, if properly conducted, would develop into a most profitable industry in many localities.

The consumption of citrus fruits in the Philippines at present is very low. The estimated production of these fruits in the Islands is valued at only about three quarters of a million pesos, while their annual importation is valued at a little over half a million pesos a year. Hence the value of citrus fruits consumed in the Islands is about one and a quarter million pesos, or only 11 centavos per capita, per year. The annual per capita consumption of citrus fruits in the United States is about ₱9 (Cal. Citrograph, Vol. IX, p. 90 and Vol. XIV, p. 103). When sufficient quantities of good citrus fruits become available at moderate cost, it is probable that the consumption of these fruits in this country would readily increase many times.

Conditions are extremely favorable for a profitable citrus industry in the Philippines today. Citrus fruits naturally appeal to the average palate, and their value as a supplementary food in the diet and in a medicinal way is well established. Improved varieties of citrus here have shown under experimental tests that they are capable of yielding very profitable returns, and the fruits produced are as good as those grown elsewhere. However, the grower should plant only the native and foreign varieties adapted to conditions on their farms, grow trees budded on suitable stocks, adopt the most suitable systems of culture and prepare and market their fruits in the most advantageous manner to make a good profit.

SOIL, RAINFALL, AND LOCATION

While a loose, friable well-drained soil of the lighter type is preferable, citrus trees succeed well even on heavier soils, pro-

vided that they are deep, well drained and supplied with organic matter. Extremely sandy soils and very sticky soils are not good because they possess serious disadvantages. Soils underlaid with hard, impenetrable layers are undesirable for the growing of citrus.

If the precipitation is well distributed throughout the year without prolonged dry periods, an annual rainfall of 1,000 to 1,250 millimeters is enough, but where most of the rain falls in the course of a few months, and a long period of dry weather follows, irrigation becomes necessary, unless the soil moisture which is supplied by the water table during the dry season is within the reach of the roots of the trees. The evil effects of a prolonged dry season where irrigation is not practicable can, to some extent, be mitigated by the judicious use of cover crops and mulches, which practices increase the moisture-holding capacity of the soil during the dry season.

Proximity to a prospective market with attendant transportation and the costs thereof should receive serious consideration in deciding upon a location for a citrus grove. Other important considerations are the adaptability of the locality for the culture of these fruits, freedom from frequent typhoons, and also the fertility of the soil.

VARIETIES

The question of selecting the right varieties for the individual locality is a most important one. Fortunately, there are many local forms to select from, and moreover, within the last twenty years, hundreds of varieties of the different citrus species have been imported from many countries for trial planting here. While the most of the latter will probably be eliminated as not adapted to our conditions, many have already proved very promising.

The citrus varieties which are at present considered the most promising and should therefore be tried for commercial or home orchard plantings are the following:

Citrus aurantifolia, SWINGLE. Limes (Tagalog: Dayap).

Tahiti lime, P. I. 5163.—A low growing tree with dense foliage. The fruit is as large as a lemon, oblong to roundish, and has a clean, attractive appearance. Flavor excellent. Six-year-old trees at Tanauan, Batangas, yielded and average of 125 fruits (per year) last year.

Kusaie lime, P. I. 5184.—Small but very prolific tree, free from citrus canker. The fruits are the size of hen's eggs, clean

and of fine appearance. Flavor good. A six-year-old tree of this variety yielded 500 fruits in 1929.

Citrus grandis, OSBECK. Grapefruits.

Marsh seedless grapefruit, P. I. 1631.—Tree is of medium size with a round crown. It is quite susceptible to citrus canker and the fruit is much attacked by the rind borer. However, it is of excellent quality and is usually seedless. The variety has proved to be a shy bearer at Tanauan, Batangas, although at Lamao, Bataan, the trees used to bear well.

Duncan grapefruit, P. I. 2687.—The tree is of rather slow growth but prolific. A small tree, 6 years old, yielded 31 fruits last year, at Tanauan. The fruit is large and has an excellent flavor. The variety is quite susceptible to citrus canker.

Triumph grapefruit, P. I. 1713.—The tree is of good growth, resistant to citrus canker, and fairly prolific. The fruit is of medium to large size. The flavor is not bitter like that of other grapefruits, and it may be eaten without sugar.

Citrus grandis, OSBECK. Pummelos (Tagalog: Lukban, suhá).

Siamese seedless pummelo, P. I. 3442, 3673.—The tree has a rather straggling habit of growth, and comes into bearing 3 or 4 years after planting. Grown on sour orange stock a tree of this variety yielded 33 fruits in 1929, at five years of age. The fruit is usually seedless, of good keeping quality. Its flesh is juicy and has a very pleasant flavor.

Selected native pummelo, P. I. 7410.—The tree is of vigorous growth with low and widely spreading branches. Its fruit is large, round and of a good keeping quality. Its rind is of a very attractive vermilion color, and is of medium thickness. The flesh of the cured fruit is pink in color, easily separated from the envelope, and pleasantly flavored. A tree of this variety, 8 years old, bore 30 fruits in 1929 in Tanauan.

Yugelar pummelo, P. I. 3391, 3392.—The Yugelar pummelos are valuable varieties from Siam. Their fruit has not, as yet, been described in the Philippines.

La Union pummelo, P. I. 8861.—This tree is of rapid growth, with upright branches. The fruit is oblate, small sized, thin skinned, with juicy, whitish pulp. The flavor is very pleasant. The trees at Tanauan matured their first crops of fruit at 5 years of age, yielding an average of 6 fruits each.

Saigon pummelo, P. I. 3384.—The trees of this variety are of vigorous growth, resistant to citrus canker and with well-formed

heads. Grown on rough lemon stocks, the seven-year-old trees at Tanauan averaged 66 fruits each in 1929.

Citrus hybrids.

Sampson tangelo, P. I. 1618.—The Sampson tangelo is one of the most noteworthy citrus hybrids produced by Swingle. It is the product of a crossing between a grapefruit and a tangerine variety. As grown in the Philippines, the tree is quite strong and prolific. A top-worked tree at Tanauan yielded, in 1929, 650 fruits when 9 years old. The fruit, which is slightly smaller than the true grapefruits, has a thin, smooth and clean rind. It may be eaten as a grapefruit is or its abundant juice may be expressed, a little sugar added, and used as a drink. The flavor is agreeable.

Citrus limonia, OSBECK. Lemon (Tagalog: Limon, dayap Americano).

Thornless lemon, P. I. 1712.—Trees of this variety develop steadily into strong and fruitful trees. Seven-year-old trees averaged 237 fruits in 1929. The fruit is oblong, keeps a long time, has a fine color when cured, and contains only a few seeds. The juice is abundant and of a pleasant taste when made into a drink.

Villafranca lemon, P. I. 692.—This is a precocious and prolific variety. The tree is thornless and of fairly rapid growth. At 5 or 6 years of age, the trees averaged 270 fruits in 1929. The lemon is slightly oblong, medium to large in size and has plenty of juice.

Citrus mitis, BLANCO. Calamondin, Calamansi.

The calamondin is a native Philippine citrus fruit. Because of its many household uses, it is an important commercial fruit, and in some parts of Batangas Province its culture is very profitable.

The species propagates remarkably true to type, and there are, as yet, no isolated varieties propagated vegetatively from superior, individual seedling trees.

Citrus, nobilis LOUR. Mandarin Orange (Tagalog: Sintonis, Dalanhita).

Batangas mandarin, P. I. 8868.—The tree is of slow growth, with an upright head. Selected strains of this fruit are probably unexcelled by any other mandarin orange, in their eating quality. However, the greatest defect of the variety is the irregular bearing habit of the tree. The Batangas mandarin is a medium to large-sized orange, oblate in form, of fine appear-

ance and quality, and with a delicious flavor. Eight-year-old trees of this variety averaged 42 fruits in 1929.

King mandarin, P. I. 2693.—The tree is a fairly rapid grower, with long, upright branches. It is a precocious and regular bearer. The fruit is a large-sized orange, oblate in form, and of attractive color when well ripened or cured. The taste is pleasant. The fruit ripens late, that is, from March to April. Six-year-old trees averaged 58 fruits in 1929.

Szinkom mandarin, P. I. 1267.—Small, many branched tree, with abundant foliage. It is very precocious and prolific. The fruit is a small to medium-sized orange, clings tightly to the stem and does not windfall. The flavor is fairly pleasant, and the odor distinctive. Seven-year-old trees of this variety averaged 1,800 fruits in 1929.

Ladu mandarin, P. I. 1256.—Very similar to the Szinkom in growth character, and the tree is fairly prolific and regular bearer. The fruit is oblate in form, small to medium sized and of attractive appearance. Five-year-old trees of this variety averaged 18 fruits in 1929, in poor soil.

Oneco mandarin, P. I. 1335.—The Oneco mandarin tree has an upright growth habit like the Batangas, but promises to be a more consistent bearer than the latter. The fruit is round to oblate, medium to large, with a pleasant flavor. Seven-year-old trees of this variety averaged 114 fruits in 1929.

Ponkan mandarin, P. I. 9897 (from Formosa).—This is reputed to be the best orange in the Orient. Newly introduced. The tree has not, as yet, fruited in the Philippines.

Dancy mandarin, P. I. 1918.—The tree makes an upright, many-branched growth with fine foliage. The fruit is oblate, and small-sized, of a deep orange color when ripe. The flesh lacks somewhat in juice, although its flavor is pleasant. Seven-year-old trees of this variety averaged 137 fruits in 1929.

China mandarin, P. I. 1265.—Growth and foliage characters are very similar to those of the Szinkom. The tree is very prolific. The fruit is oblate, very small, and of a reddish orange color when ripe. Flavor excellent. Six-year-old trees of this variety averaged 1,257 fruits in 1929.

Konda narum mandarin, P. I. 1268.—This introduced variety is very similar to the Batangas, not only in growth habit but also in the flavor and appearance of the fruit. Top-worked buds of this variety bore uniformly well in 1929.

Calamandarin, P. I. 9896.—This is a new variety of mandarin originating from a Chinese seedling grown in Santor bar-

rio, Tanauan, Batangas. Its fruit is very similar to the China, P. I. 1265, although it is slightly larger, and its flavor more acidic than that of the latter. But the variety is late maturing, its fruits remaining in good condition on the trees up to April. Six-year-old buds of this variety top-worked on Batangas mandarin yielded well over a thousand fruits each in 1929.

Kishiu mandarin, P. I. 1271.—The tree is a rapid grower, with a very low and wide-spreading crown. It is an erratic and often a poor bearer. The fruit is oblate and small sized. The flesh is juicy and of a very pleasant flavor. Seven-year-old trees of this variety averaged 55 fruits in 1929.

Citrus sinensis, OSBECK. Orange (Tagalog: Cahel, dalandan).

Dougat orange, P. I. 4119.—The tree is rather a slow grower, precocious and prolific. The fruit is round or oblate, medium sized, juicy. Flavor is full, excellent.

Valencia orange, P. I. 2569.—The tree is a rapid grower, but rather poor yielder. The fruit is oblong or round, medium to large-sized, and juicy and sweet.

Misamis orange, P. I. 2568.—The tree is of fairly rapid growth and very fruitful. The fruit is round, medium sized, juicy. The flavor is excellent, the sweetness and acidity being well balanced.

Cuevas orange, P. I. 9901.—The tree is a rapid grower, precocious and a regular yielder. The orange is round, medium sized, thin skinned, and remains on the tree in good condition long after it is ripe. The flesh is juicy and of excellent, full flavor.

Laurel orange, P. I. 8856.—The tree is of good growth, precocious and a good bearer. The fruit is round to oblate, medium to large sized, juicy and of good flavor.

St. Michael orange, P. I. 1270.—The tree is a fairly rapid grower, fruitful but considerably affected by citrus canker. The fruit is oblate, small to medium sized, juicy. Flavor pleasant.

Majorca orange, P. I. 2694.—The tree is a fairly rapid grower, prolific and not much attacked by canker. The fruit is medium sized, very juicy, and of pleasant flavor.

Homosassa orange, P. I. 2691.—The tree is of fairly rapid growth, a regular bearer and prolific. The fruit is round or oblate, medium sized, very juicy. Flavor very pleasant.

Collantes orange, P. I. 9899.—The tree is of good growth and prolific. The fruit is round to oblate and very juicy. Flavor good.

Gonzales orange, P. I. 9898.—The tree is a fairly rapid grower and heavy and regular bearer. The fruit is round, medium sized, with a thin rind that colors well when cured. The flesh is juicy and has a pleasant flavor.

Pineapple orange, P. I. 2686.—The tree is a fairly good grower and prolific. The fruit is round or oblong, medium sized and very juicy. Flavor excellent, with well balanced acidity and sweetness.

Jaffa orange, P. I. 56.—A prolific and rapid-growing tree. The fruit is roundish, medium to large sized, with a rather thick rind. Flesh very juicy and of excellent flavor.

Aguilar orange, P. I. 9900.—The tree is a vigorous grower, prolific. The fruit is round, medium sized, juicy. Flavor very pleasant, with sufficient and well matched sweetness and acidity.

Balanga orange, P. I. 3660.—The tree is a rapid grower, prolific. The fruit is round or oblate, medium to large sized, juicy and of pleasant flavor.

PROPAGATION

Citrus trees in the Philippines are usually grown direct from seed. This is why citrus fruits are, as a rule, not uniform in size, appearance, and quality. Any commercial product needs both quality and uniformity to command a good price and maintain a steady demand in the market. In citrus fruit production, these qualities can only be attained by a judicious selection of varieties, raising the fruit on vegetatively propagated trees, and sending the product to the market in properly graded and prepared packages. The seedling method of propagation does not lead to a uniformity and high quality in the product, and in addition, has other serious disadvantages. It has long been discarded in modern citriculture, and the vegetative method of propagation is now in almost universal use.

Vegetative propagation is the reproduction of a plant by growing a portion of its body. While grafting and marcotting are also sometimes used, budding is by far the most convenient and most common form employed for the vegetative propagation of citrus trees.

The following advantages are derived from budding or grafting:

(1) A stock best adapted to the given soil and climatic conditions can be used to much advantage. A scion grown on a congenial stock may grow more vigorously, be more resistant to diseases and pests, and at the same time be more productive

than when the same scion is grown from its own, or other less congenial roots.

(2) Fruit of any variety, regardless of whether it contains seeds or not, can be produced in large quantities from vegetatively propagated trees.

(3) By planting budded trees, uniformity in the appearance and quality of the fruit is assured. This is highly important considering present day commercial requirements.

(4) Budded trees are more precocious than seedlings, are less spiny and do not grow so tall. They therefore (*a*) yield an income earlier than seedlings; (*b*) the gathering of the fruit entails less labor; (*c*) the control of diseases and insect pests is more easily and economically effected; (*d*) they are not so liable to injury by typhoons; and (*e*) by shading a large area of ground, they assist in preserving the moisture in the ground during the dry season, and they do not allow a rapid growth of weeds immediately around the trunk.

(5) Finally, because budding or grafting as a means of propagation reproduces the variety more accurately than the seed method, rapid improvement in the quality and quantity of fruit of the desired variety is made possible by simply selecting and propagating scions of that variety.

Scion and stock.—A budded or grafted plant is composed of two parts—the scions, or upper part, and the stock, or lower. The scion and the stock are made to join to form the budded or grafted tree. The scion furnishes the fruiting part and the stock the roots of the tree.

Both the scion and the stock should be carefully selected. The scion should bear the desired kind of fruit and therefore it should be cut from branches known to yield that fruit only. On the other hand, the stock possesses certain adaptabilities in regard to the condition and quality of the soil, and also in regard to the kind of scion. Therefore to obtain the best results from the planting of a budded tree, the stock should be well adapted to the scion variety and to the particular soil on which it is planted, and it should be resistant to diseases.

The following suggestions on the adaptabilities of a few citrus stocks are based upon the experience of the Tanauan Citrus Experiment Station and the Lamao Experiment Station in the growing of budded citrus trees:

Batangas mandarin.—Has well developed, shallow root system. Recommended as stock for all mandarins, oranges, pummelos, and grapefruits, and the Tahiti lime.

Orange.—Fairly well formed root system. Recommended as stock for oranges, mandarins, lemons, and pummelos.

Rough lemon.—Has well developed root system. Imparts vigor of growth to scion. Recommended as stock for lemons, calamondin, limes, mandarins, and grapefruits.

Sour orange.—Has good root system, resistant to foot rot. Recommended as stock for Siamese seedless pummelo, lemons, and oranges.

Calamondin.—Has a weak root system. Recommended as stock for limes, oranges, and mandarins.

Pummelo.—Has a well developed root system. Difficult to bud because of the thickness of the bark. Recommended as stock for pummelos and lemons.

TABLE SHOWING THE SIX STOCKS AND THEIR DEGREES OF ADAPTABILITY TO THE DIFFERENT SCIONS

Scion variety	Batangas mandarin stock	Orange stock	Rough lemons stock	Sour orange stock	Calamondin stock	Pummelo stock
Mandarins	Very good	Very good	Good	Fair	Fair	Poor
Satsuma mandarin	Fair	Not known	Not known	Poor	Good	Not known
Oranges	Very good	Very good	Fair	Fair	Good	Poor
Limes	Poor	Not known	Good	Not known	Very good	Not known
Tahiti lime	Very good	Not known	Very good	Not known	Poor	Not known
Kusaie lime	Good	Not known	Not known	Not known	Good	Not known
Lemons	Poor	Good	Very good	Fair	Poor	Good
Pummelos	Very good	Good	Good	Not known	Poor	Very good
Siamese pummelo	Very good	Good	Fair	Very good	Poor	Fair
Grapefruits	Good	Not known	Good	Not known	Poor	Not known

The numerous varieties of *Citrus aurantifolia*, *C. hystrix*, and *C. webberii* should also be tried for stock purposes, to determine their adaptabilities to the different scions.

The citrus nursery.—One of the first steps in the growing of citrus orchards is the raising of budded trees for planting. A knowledge of the methods and operations involved in this work is very important at present because of the difficulty of securing budded plants of the desired citrus varieties in sufficient quantities. There are no commercial nurseries which supply the plants required and although the Bureau of Plant Industry, in coöperation with some municipal and provincial governments, undertakes to propagate the most promising citrus varieties known, the supply from such sources is at present very limited. Therefore the most feasible way to secure a sufficient number of budded citrus trees for a commercial orchard is to raise them right on one's own plantation.

The nursery work begins with the growing of the seedling for stocks. This is done first by planting seeds of the proper

varieties closely in beds or in seedflats. When the latter are used it is necessary to remove the seedlings when they are 8 or 10 centimeters high and transplant them in well-prepared beds before they are finally set out in the nursery rows. If the seedlings are raised in beds from seed, this intermediary transplanting need not be done.

When the seedlings have attained the height of about 30 centimeters, they are set out in nursery rows where they are to be grown until they are budded. The seedlings should be root-pruned by cutting off one-fourth of the length of the roots and then planting them in the rows. This last treatment encourages the development of strong lateral roots.

A field having a rich, clay loam soil, free from cogon, is most desirable for the nursery rows. These rows should be about 1.2 meters apart on one side, and about 40 centimeters on the opposite side. In this manner, there would be a pair of rows 40 centimeters apart, separated from the next pair of rows by a path 1.2 meters wide (Plate I). The seedlings are planted in the rows about 40 centimeters apart.

The seedlings may be budded when they have stems as large as, or larger than, a lead pencil. In order to insure success in budding them, the stock seedlings should be in a good healthy condition, which may be attained by maintaining the soil in a fertile state, by weeding the rows and by watering them whenever necessary. If the seedlings are kept in a vigorous growing condition while they are in the nursery rows, much time will be gained in the production of the budded trees, because they come into size for budding early and will "take" the buds easily.

Budding tape for wrapping the bud on the stock is prepared as follows: first, get a piece of fine meshed, cotton cloth (starched muslin), and cut it crosswise into strips 25 centimeters wide. Prepare round bamboo sticks about 1 centimeter in diameter, and 27 centimeters long. Roll one or two strips of the cloth (each about 92 centimeters long), evenly and rather tightly on each stick.

Melt in a tin vessel 1 kilo of beeswax, 2 kilos red resin, and 150 grams of beef suet, over a slow fire. A convenient tin vessel for this purpose is the lower half of a 5-gallon kerosene can. Do not overheat the mixture as it is liable to boil over. As soon as all the materials are melted, immerse the rolls of cotton in the melted wax for from 10 to 20 minutes and then remove them and put them aside to cool.

The budding operation.—Ordinary budding, called "shield budding" is performed as follows: Make a vertical cut, 3 to 4 centimeters long, through the bark to the cambium layer of the stock. At the lower end of the cut, make a horizontal cut so that the wound appears like an inverted T (Fig. 2). In making the latter cut, the blade of the budding knife is directed upward, in a slanting position, and by swinging its handle forward horizontally, the edges of the bark at the lower end of the cut are loosened.

Cut the bud to be inserted by passing the blade of the knife under it, slicing off a shield-like piece from the budstick (Fig. 3). This shield-like piece contains the bud to be grown and is called the "shield bud" (Fig. 4). This piece should be from 2 to 4 centimeters long and cut off cleanly so there will be no splitting or tearing of its tissues. It is advisable when slicing the bud to hold the budstick with its end toward the cutter, as then the wood is less likely to split than when it is held in the reverse position (Fig. 3.).

The shield bud is slipped under the bark of the stock by inserting the upper end of the shield under the loose flaps of bark at the lower end of the wound and then gently pushing it upward until the entire shield bud is completely under the bark (Fig. 5.).

Then with a strip of the budding tape 15 to 20 millimeters wide, the bud is covered and tied firmly on the stock (Fig. 6). If budding is done during the rainy season, the covering should extend well beyond the ends of the cut to be sure that water does not get into the wound. The wrapper may also be doubled as a further precaution.

Ten to 15 days after being inserted, the bud should be examined and if it appears as green as when it was inserted, or if the wound has callused, the bud has taken, and the covering it to be left partly open (Fig. 8), so as to expose the bud to the air. A cut one-third of the diameter of the stem of the stock, 5 centimeters above the point of insertion is then to be made. A weekly inspection should be made and each time the cut should be made deeper; then the top of the stock should be bent down (Fig. 9). Both of these operations tend to force the bud to grow.

When the bud has attained a growth of about 25 to 30 centimeters long, the top of the stock may be cut off entirely just above its point of union with the bud. The exposed wood should be painted with white lead or asphaltum-linseed oil paint as a protective covering while new bark grows over it (Fig. 10).

Thereafter all wild sprouts coming from the stock should be removed as they appear, so as to concentrate all the energy of the plant on the growing of the scion.

The following are important requirements for success in budding:

(1) The stock and scion should have affinity in order that they will form a union.

(2) The stock plant should be in good growing condition so that the bark separates easily from the cambium layer and the shield bud can be readily inserted in place.

(3) A suitable budding knife (Fig. 1), the edge of which is as sharp as a razor.

(4) Budwood of the proper age (Fig. 7). In citrus, the best budwood comes from the first, second, and third zones of the stem, behind a mature fruit. In the absence of this kind of budwood, a round twig, green streaked with gray, and containing well marked buds, will also do.

CLEARING THE LAND FOR AN ORCHARD SITE

If the site for the orchard is wooded or overgrown with shrubs, the land should be cleared and stumped a year in advance of the planting of the trees and then planted to cowpeas, mango, or other legumes that are known to grow well in the locality.

As a preparation for the planting of the trees, the field should be plowed and harrowed once or twice. In case cogon is present in the field, pains should be taken to entirely eliminate it before any tree is planted, as this pernicious weed would be much more difficult to eradicate after the trees have been set out.

PLANTING

The distance apart at which the trees should be set out varies with the variety and the fertility of the soil. As a rule, the distance between trees should be greater the richer the soil is, other conditions being equal. The following table gives the range of spacing at which budded trees of the different species should be planted. However, inasmuch as varieties within a given species of citrus vary much regards their character and vigor of growth, the table of given distances should be considered as a rough guide only. The exact planting distance for any given variety and locality can be determined only by experience.

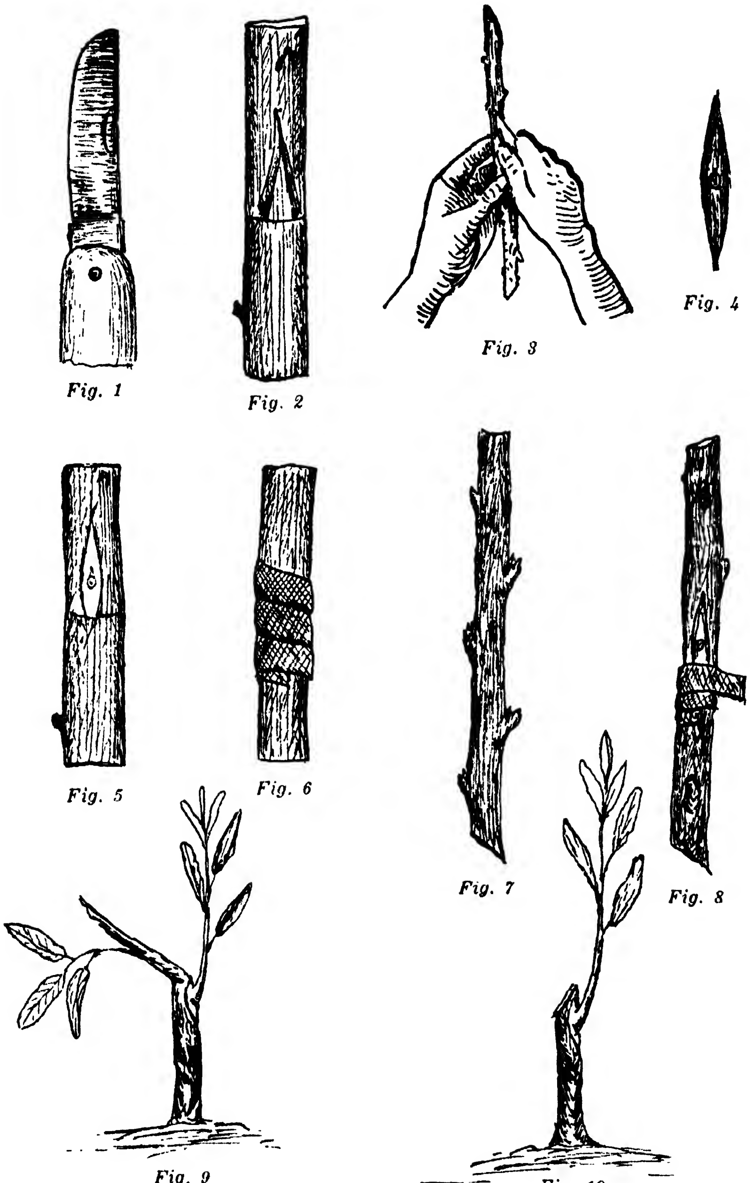

FIG. 1. Budding knife.
2. Stock ready for insertion.
3. Cutting a shield bud.
4. Bud.
5. Bud inserted.

FIG. 6. Bud inserted and tied.
7. Petioled budwood.
8. Partly opened budding.
9. Lopping the stock.
10. Cutting off the stock smoothly.

	Meters
For large varieties of mandarin	6 –7
For small varieties of mandarin	5 –6
For orange and lemon varieties	5.5–6.5
For pummelo and grapefruit varieties	6.5–8
For calamondin and lime varieties	4.5–6

Having decided upon the distance apart of setting the trees the next step is the staking of the field. The system of planting trees universally used in the Philippines is the "square system." The trees are set out in equal distances apart and in straight rows crossing each other at right angles. This system has a great advantage over the other systems because of simplicity and the ease with which the stakes are laid out. Another system, also very simple, is the "rectangular system" of planting. This is very similar to the square system, the only difference being that the four adjacent trees are set in the corners of a rectangle instead of a square. Needless to say, the rows of trees must be straight.

The hole for an ordinary-sized tree should be not less than 40 centimeters deep and 50 centimeters wide. It is a good plan to separate the earth dug out of the hole into two heaps—one from the upper and the other from the lower layer of soil. In planting the tree, the rich soil from the upper layer only should be used in covering the roots. The tree should be set as deep as it stood in the nursery.

The early part of the rainy season is generally considered the best time for planting citrus trees because of the abundant natural supply of moisture when they are getting established in the soil. However, the trees may be planted any time provided they can be kept watered during the dry season.

It is best to remove the tree from the nursery with a ball of earth around its roots so that the shock of transplanting will be felt as little as possible. A long tap root should be cut shorter, while as much of the sound lateral roots as possible should go with the plant. These roots should be straightened out and spread apart before being covered with soil. The trees should not be set deeper than they stood in the nursery. To encourage the tree to make a rapid growth only fine surface soil should be used for filling the hole. As the filling goes on, the soil should be carefully compacted. When it is completed, the tree should be liberally watered to establish a capillary contact between the soil and the roots, unless the rain falls shortly after.

MAINTENANCE OF THE YOUNG GROVE

A combination tillage and cover-crop system of maintaining the newly planted grove is both economical and convenient. Moreover, such a system encourages the development of a thicker and deeper root system for the trees, conserves satisfactorily the fertility of the soil, and allows the grower, if the soil is rich, to derive an income from the land while the trees occupy but little of the space.

This system consists essentially in growing suitable legumes in the grove, such as soy beans, cowpeas, mongo, anipay, etc., during the rainy season, and then maintaining the soil in a state of tilth during the dry season.

The leguminous cover crop should be grown mainly as such and should be of a heavy growth in order to yield a large quantity of green manure for the trees. Needless to say the planted trees should be attended too often enough to keep them free from the smothering action of the growing cover crop. When the cover crop has matured, the ground should be plowed to incorporate the vegetable material with the soil.

During the dry season the ground should be kept under frequent cultivation. However, the ground immediately around the trees should be kept undisturbed by the plow or cultivators, as otherwise more harm then good would result. The ground near the trees should be hoed to keep it clean, and then mulched thickly with leaves.

Interplanting.—If the soil is rich, the ground between the newly set out trees may be interplanted with quick growing plants such as pineapples, papayas, bananas, etc., to furnish an income from the land while the trees are yet too small to occupy much of the ground. An arrangement which might prove profitable is to grow one banana or papaya tree in the middle of each space enclosed by 4 citrus trees, while 2 or 3 rows of pineapple are grown in line with each row of citrus trees. An area of 2 to 2.5 meters wide along each row of trees and pineapples should be kept clean of weeds and cover crops.

MAINTENANCE OF THE CITRUS GROVE OF BEARING AGE

The cultural treatment of the grove after the second year of its existence is modified with the object of preparing the trees to bear fruit as early as possible. A suitable perennial leguminous cover crop is planted. Deep tillage is discontinued, and surface cultivation, which is carried on mainly for the purpose of eliminating the weeds, takes its place. The soil fertility is

kept up by the intensive use of soil enriching legumes for cover and green manuring.

This system of maintaining bearing groves has been thoroughly tried at the Tanauan Citrus Experiment Station on all kinds and ages of citrus plantings with excellent results. It enriches the soil rapidly in nitrogen and humus. Because the ground need not be broken periodically, it encourages the intensive formation of the feeding roots of the trees in the upper and richer layers of soil. Under these conditions, the grove is brought into fruting early.

Establishment of a continuous cover crop.—The ground is first prepared thoroughly with plow and harrow. Then a suitable perennial legume is planted rather closely in rows between the trees. For this purpose, ipil-ipil, cacahuate and *Tephrosia candida* have been used with almost equal success at Tanauan.

The ipil-ipil or Tephrosia rows should be about a meter apart, and 4 to 8 seeds are planted in hills, 30 to 40 centimeters apart. For the cacahuete wider spacing should be employed. It is most desirable that a thick and even stand of the cover crop be secured so as to smother the growth of weeds which are likely to come up.

These legumes may be planted in the early part of the rainy season, although in Batangas Province the latter part of the rainy season has been found to be better for the ipil-ipil and the Tephrosia.

Weeding should start when the cover-crop plants are still very young to give them a chance to develop more rapidly. Every effort should be made to eradicate cogon as fast as it appears in the field, because the presence of a dense growth of cogon greatly hampers the proper development of cover crops and citrus trees.

In from 6 to 8 months the cover crops will have grown so high that it should be trimmed down. Otherwise, it would compete severely with the citrus trees for air, sunshine and moisture. This trimming down should be repeated every 3 or 4 months. The cover crop plants are to be cut down to about 2.5 feet above the surface of the ground, with an upward swing of the bolo so as not to split the remaining stems. The rows of citrus trees should be made open to allow a free movement of air. For this purpose, a space 1 to 2 meters wide along the rows of trees should be kept clean of weeds or cover crop.

The vegetable material obtained from the cut cover crop growth is an excellent green manure and every time such a

growth is trimmed, this material should be thrown onto the ground, around the bases of the trees, to enrich the soil immediately surrounding them as rapidly as possible. The quantity of green manure which may be obtained from the regular trimming of a cover crop is immense. In a soil of average fertility at the Tanauan Citrus Experiment Station, a 2-year-old Tephrosia cover crop yielded 36 tons of green manure in 1926. This quantity of green manure was obtained by cropping its growth three times during the year. More than two-thirds of this material was soft, easily rotted green manure.

FERTILIZATION

The problem of increasing and maintaining the fertility of the soil is very important, especially in a bearing orchard. The heavy demand by the fruit crop for plant foods must, in the long run, be met or else the condition and yields of the trees will prematurely decline. In poor soils, young citrus plants should also be given the proper fertilizers.

In the effort to enrich the soil by the use of commercial fertilizers, the value of humus to the soil should not be lost sight of. Humus is perhaps the most important constituent of a rich soil because it increases the moisture-holding capacity of the soil, it helps to make available the plant foods held by the minerals in the soil, furnishes nitrogen, and improves the physical and biological condition of the soil. Fertilization in a continuously cover cropped orchard has been found to be very effective, presumably because of the beneficial action of the humus supplied abundantly by the cover crop. In the absence of cover crops or green manures as sources of humus, organic fertilizers should be used to supplement the commercial fertilizers applied to the soil.

There are three principal food materials required by plants which are often deficient in the soil. These are nitrogen, phosphoric acid, and potash. A fertilizer containing all of these plant foods is called a "complete" fertilizer. It should be used whenever a soil is not definitely known to be deficient in only one or two of these plant foods. As a matter of fact, some soils may require only an "incomplete" fertilizer. In such cases, one or two of the three plant foods need not be purchased and applied. To determine which or how much of these plant foods need be applied to be most effective for any given soil, simple fertilizer tests should be conducted.

It is generally accepted as a fact that a young citrus grove requires a fertilizer richer in nitrogen content than a bearing grove. A fertilizer containing 10 per cent nitrogen, 6 per cent phosphoric acid, and 2 per cent potash is recommended for young citrus trees. Fertilizers of this composition are readily available in the market, under various trade names. A tree 1 year old should be given about 0.2 kilo, a two-year-old tree about 0.5 kilo, and a three-year-old tree about 1 kilo of this fertilizer, per year.

For bearing trees 4 years or more of age, a fertilizer mixture containing 8 per cent nitrogen, 6 per cent phosphoric acid, and 4 per cent potash, is recommended. From 2 to 6 kilos of this fertilizer should be given each tree per year, depending upon its size.

The foregoing recommendations must be considered as rough guides only, in the absence of exact data as to the fertilizer requirements of any given soil. As soils vary in composition, they must vary in their fertilizer needs.

Ammonium sulphate, sodium nitrate, ammo-phos, bat guano, superphosphate, potassium sulphate and horse manure have been tried and found good fertilizer materials for citrus trees. Undoubtedly, many other materials would also prove to be good sources of plant foods for citrus. But copra meal should not be used as a source of plant foods for citrus trees.

It is good to divide the amount of fertilizer for one year into two equal applications, one-half in the latter part of the rainy season, and the other half in the latter part of the dry season.

The fertilizer should be evenly spread on the ground around the tree in an area from one-half to a meter wide, and from 25 to 75 centimeters away from the base of the tree. After its application, the ground should be hoed 3 or 4 inches deep, to incorporate the fertilizer with the soil.

WINDBREAKS

Windbreaks are necessary in localities where strong winds regularly occur, for unless protected, the foliage and fruit of citrus trees will suffer much due to the injurious action of such winds. Windbreaks also afford considerable protection to the trees in times of typhoons. The absence of natural wind barriers can be remedied by planting along the borders of the grove quick growing trees or shrubs. Ipil-ipil, bamboo, etc., planted thickly in rows, are well suited for this purpose.

PRUNING

Pruning is necessary in the citrus orchard for the following reasons:

(1) To remove sprouts interlocking and unnecessary branches.

(2) To remove dead or dying branches and twigs.

(3) To arrest the advance of wood rot in the tree.

(4) To train the growing tree so that it will develop a strong framework and a proper form.

The tree should have only one trunk up to a height of 30 to 50 centimeters above the ground. Multiple trunks frequently cause premature degeneration of a tree, because in their growth they soon press upon each other, and disturb the circulation of the sap. Moreover, they invariably form a receptacle in which dirt and water accumulate, soon causing bark rot and wood rot to set in.

All pruning work should be done properly and with the utmost care. Otherwise it is worse than useless. The bolo should never be used as a pruning tool.

The tools required in pruning work are: a cross-cut saw, pruning shears, pruning knife, chisels, a hammer and a light ladder (Figs. 11 to 14). For tree surgical work, special tools such as gouges, braces and bits and scrapers are also needed.

All pruning cuts larger than a centimeter in diameter should be covered with a suitable paint. A white lead-linseed oil, or an asphaltum-linseed oil mixture is a good protective paint for this purpose. The latter material, however, is preferred because it is more durable and cheaper than the white lead preparation. This is prepared by slowly heating and melting asphaltum and then adding from 300 to 400 grams of linseed oil to every kilo. Coal tar is injurious to the live wood of citrus and therefore should not be used for covering pruning cuts.

In removing a branch or a twig, the cut should be made cleanly and at the point where the branch or twig originates. The surface of a cut larger than 2 centimeters in diameter should be smoothed with a chisel or knife before paint is applied. No stub should be left after the cut has been made. Bark renewal at the end of a stub is very slow at best, and it is generally impossible (Figs. 16 to 18).

The pruning work should be started when the dry season is well under way. All prunings should be collected and burned so as to destroy any disease germs they may carry.

HARVESTING AND MARKETING

The proper handling and marketing of the fruit is very important to the citrus grower because, no matter how productive his trees are, or how excellent the quality of his fruit is, the labor of producing it will not be well compensated, unless these phases of the industry are properly conducted.

The present methods of handling citrus fruits in the Philippines are simple and crude, yet it must be admitted that under present conditions, they answer the purpose fairly well, and the loss of fruit is not excessive. However, these methods could be greatly improved. If the fruit is to undergo trips of more than 2 or 3 days' duration, it should be packed in boxes or crates instead of baskets. The chief advantages of the use of boxes over that of baskets as citrus-fruit containers are:

(1) Uniform-sized fruits can be packed neatly and with the least injury to them due to pressure.

(2) Boxed fruit withstands rougher treatment in transit than fruit carried in baskets.

(3). A better arrangement in the holds of ships, or in cars or trucks can be made with boxes than is possible with baskets.

Before citrus fruits are packed they should be placed in an airy place for at least two days. The object of this aëration is to make their rind soft and tough so that the fruits will not be easily injured during the packing operations. Fruits of a uniform grade and size should be packed only in a container that is so labeled as to convey a correct idea to the buyer of the kind and quality of the product.

CITRUS FRUIT STORAGE AND CURING

Experiments conducted by the Tanauan Citrus Experiment Station have shown that native citrus fruits can be stored in an underground chamber profitably for from one to three months. The appearance and eating quality of fruits kept in such a chamber for two weeks or more noticeably improve.

The method of storing and curing citrus fruits in the underground chamber, which was fully described in an article, "The Natural Storage and Curing of Batangas Mandarin Oranges (*Citrus nobilis* Lour) in an Underground Cement Chamber," Philippine Agricultural Review, Vol. XXII (1929), p. 171, may be briefly stated as follows:

The storage room consists of an underground chamber having cement walls and ceiling. It has a ventilating system composed of holes in the form of chimneys at the top and a woven wire

Fig. 11

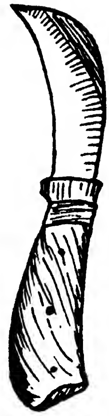

Fig. 12

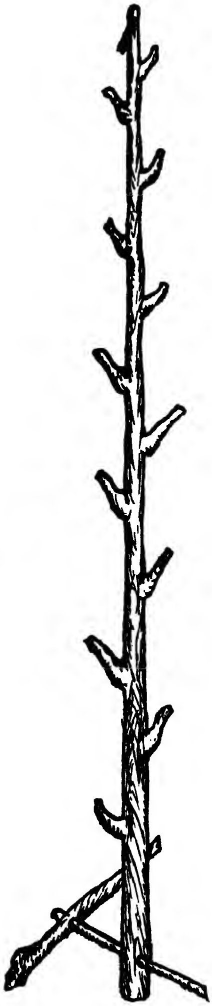

Fig. 15

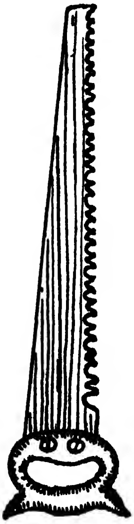

Fig. 13

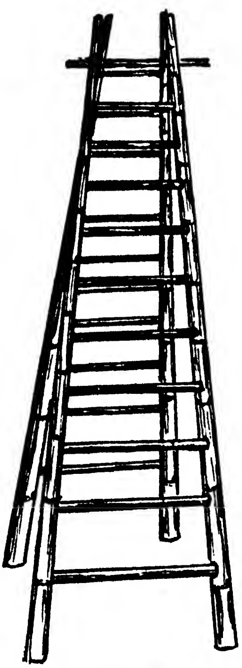

Fig. 14

FIG. 11. Pruning shears.
12. Pruning knife.
13. Pruning saw.

FIG. 14. Pruning ladder made of bamboo.
15. Ladder used in the removal of Loranthus parasite.

door. An outer door, made of framed No. 24 galvanized iron sheeting, shuts in over the woven wire door.

During the period of fruit storage, the outer door is opened at night to allow the cool air to run through the chamber. During the day this door is closed to keep the hot air outside from getting in. Thus the cool temperature of the air gained during the night is largely preserved during the day.

The earthen floor of the chamber also helps to cool the inside air by evaporation of its moisture.

The storage space is made up of shelves constructed with board frames and a bamboo slat floor. Fruits carefully picked and handled are placed one layer on each shelf. Then regular inspections of the fruit stored are made and decaying fruits removed.

DISEASES OF CITRUS

Bark diseases.—The most common as well as the most serious diseases of citrus trees in the Philippines are those of the bark. The bark- and foot-rot of mandarin, gummosis of lemon and lime, and the scaly bark of orange and pummelo trees make heavy tolls on the lives of trees. Pink and phythopthora diseases are also frequent sources of trouble in the groves, especially during the rainy season. As with other serious diseases, the bark diseases of citrus trees should be controlled by both preventive and curative measures.

The measures which tend to prevent these diseases in the grove are: (1) maintenance of the proper physical and chemical conditions of the soil; (2) training the young tree so as to have it develop only one trunk, and pruning the old tree yearly so as to remove dead or dying branches and twigs as sources of infection; (3) spraying the trunk and branches of the tree with lime sulphur solution. Needless to say, these diseases can be more readily cured when they are in their incipient stages than when already far advanced.

Curative treatment for bark rot and scaly bark.—Local treatment consists in first removing strips of bark 1 millimeter wide and 1 centimeter apart, over and slightly beyond the diseased area of bark (Fig. 17). The entire area is then painted with carbolineum, pains being taken to thoroughly wet the grooves with the liquid.

The removal of the strips is facilitated by the use of a special knife (Fig. 19–*b*), which should always be drawn parallel to the axis of the trunk or stem treated. The longitudinal cutting of the bark makes its regeneration faster than cross-cutting it.

Any debarked area of wood that was previously diseased, should be scraped clean and then painted with asphaltum-linseed oil paint.

As scaly bark and bark rot are highly infectious diseases, the bits of bark removed by the treatment should be collected and burned.

Curative treatment for foot-rot.—The following treatment has been found very effective in curing the foot-rot disease of Batangas mandarin trees. Remove the soil around the base of the trunk affected; scrape off all dead bark and clean the surface of the wood until the sound tissues are reached; treat the newly affected bark around the debarked portion in the same manner as bark-rot is treated with carbolineum; then wet the entire area with a strong solution of lime sulphur or lime sulphur sludge. After the surface has dried, paint the debarked area of wood, together with the edges of the surrounding bark with asphaltum paint. Then cover the entire base of the trunk with fine clean soil, until it is higher than the level of the surrounding ground.

Home-made tools which are very useful for the treatment of the bark diseases are shown in Figure 19.

Phythopthora and pink diseases.—These two diseases are very similar in form and both attack the trees most frequently during the rainy season. A ring of bark from a few to several inches long is destroyed. Soon the portion of the stem above this ring dies.

Spraying the trees with lime sulphur solution—once at the close of the rainy season and again at the start of the wet season—will greatly minimize the infection. If the diseases are discovered before they are fairly well advance, the stem affected may be saved by scraping off the diseased bark to the cambium layer, and then applying over it a 5% lysol, or a 0.1% corrosive sublimate solution. If the stages of these diseases are well advanced, the stems can not be saved. In these cases, they should be cut off and burned.

Die-back and wither-tip.—These diseases are indicated by the presence of many dead or dying twigs at the end of branches. While these diseases may be pathological in nature, they are believed to be induced and aggravated by poor soil and nutritional conditions.

Remedy.—The dead twigs should be pruned and the trees sprayed with lime sulphur solution, 1 to 12. The preparation of a home-made stock solution of lime sulphur is described under

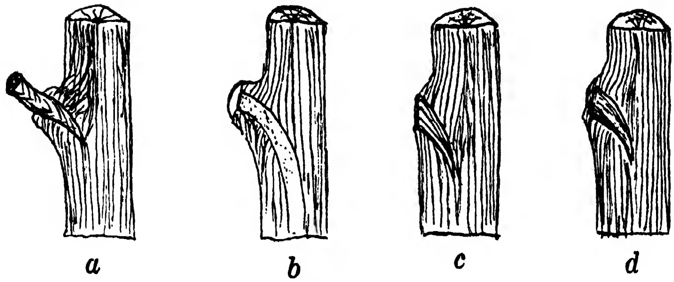

Fig. 16

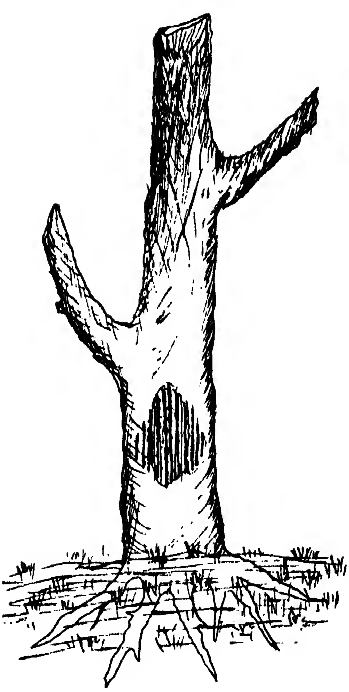

Fig. 17

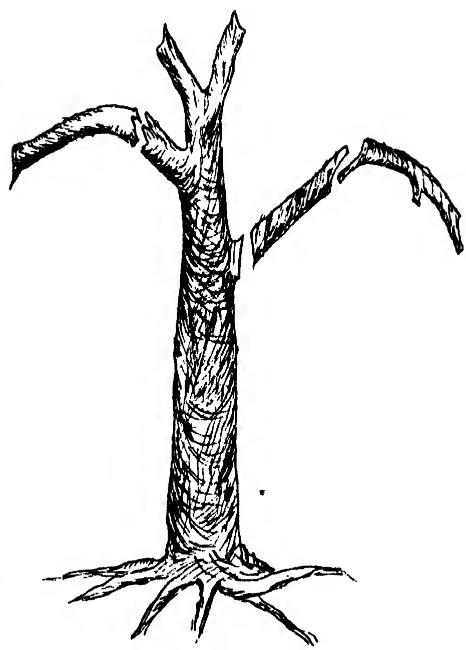

Fig. 18

FIG. 16. (*a*) Incorrect pruning method. · (*b*) Result in heart rot. (*c*) Correct pruning method. (*d*) Result in sound healing of bark.

FIG. 17. Treatment of bark with carbolineum.

FIG. 18. Showing correct and incorrect ways of pruning branches.

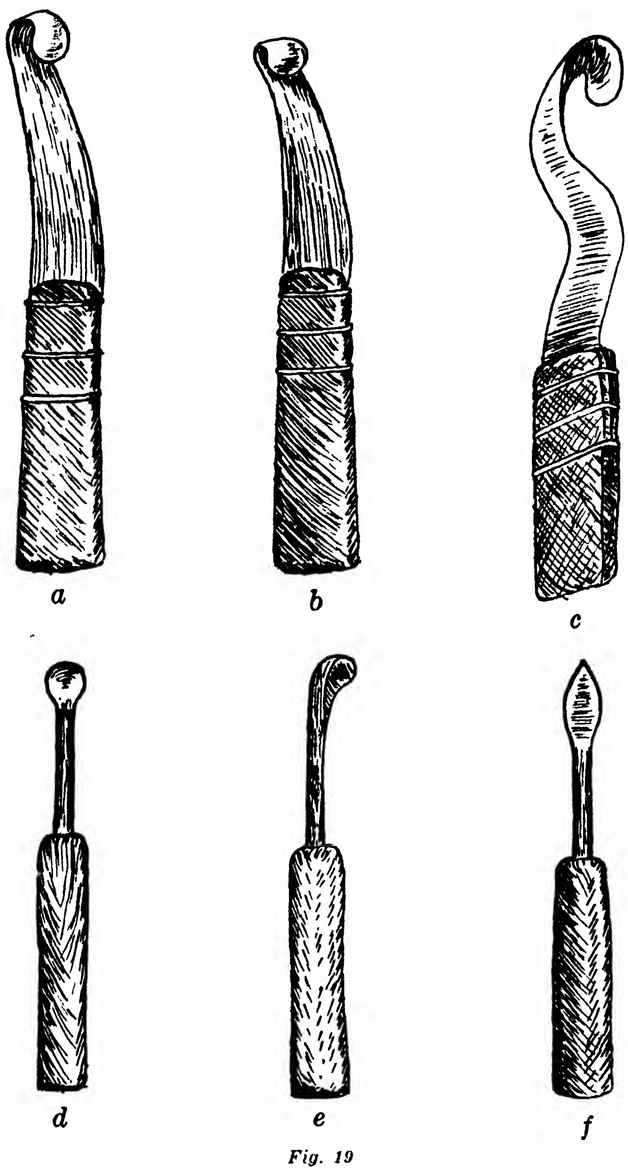

FIG. 19. Home made instruments used in the treatment of foot-rot and bark-rot.

the subject "Lichens." Leguminous cover crops should be grown in the orchard to replenish the nitrogen and humus content of the soil. Light applications of commercial fertilizers to supplement the cover-crop treatment greatly hasten improvement in the condition of the trees.

Citrus canker.—This is a very pernicious disease attacking practically all kinds of citrus. The infection appears as small, light brown spots, from less than 1/16 to 1/4 of an inch in diameter. The spots are usually round, and may occur singly, or several may run together, forming an irregular area. Leaves, young twigs and fruits are affected.

The citrus groups most seriously attacked by canker are the grapefruit, sweet orange, pummelo, lime and the lemon. Fortunately, however, with the possible exception of the grapefruit, there are varieties within these groups which are resistant to the disease. The mandarin orange and the calamondin varieties are, in general, but slightly affected.

Remedies.—Only varieties which have shown strong resistance to the disease should be planted. Spraying the young foliage and fruit of citrus trees at close intervals with Bordeaux mixture or lime sulphur solution, is effective as a cure.

COMMON CITRUS INSECTS

Rindborer (Prays citri, Milliere).—One of the most destructive insect pests of citrus in the Philippines is the rindborer. This insect attacks and destroys the flowers and young fruits of its hosts. Older fruits are also attacked and are rendered unsightly and of little commercial value. The presence of this insect makes it unprofitable to grow varieties of sweet orange, pummelo, grapefruit and lime, in a grove as these are very susceptible to its attack.

The rindborer adult, which is a tiny moth, deposits its eggs on the rind of the fruit. The irritation caused by the larva inside the rinds causes the production of characteristic swellings on the fruit, which in most cases render it unfit for commercial purposes. The larval stage lasts about 40 days. The mature larva emerges from the swelling, through a hole as large as a pin hole, and goes to pupate in an inconspicuous place on the twig. The pupal stage lasts only five days.

Control measures.—The pupae are killed with a spray of soap solution (400 grams Chinese soap in 20 liters boiled water). Collecting and burning the infested fruits helps much in reducing infestation.

Another means of suppressing the rapid propagation of the rindborer is the inclusion of a considerable proportion of lemon and Tahiti lime trees in the citrus planting. This is believed to be effective, since it has been observed that while the lemon and lime fruits are much attacked, the rindborer larvae very rarely are able to mature in the rinds of these fruits. Possibly because of the abundance of oil in their rinds, the larvae make an abnormally weak growth, and almost always die inside the rind, without emerging as pupae. As these varieties of citrus trees are everbearing, they serve as a continual natural death trap for the insect.

Citrus bark borer (*Agrilus occipitals, Eschesch*).—The larva of this insect is perhaps the most deadly enemy of orange, mandarin and lemon trees in the Philippines. It works under the bark of trunks and branches, often unnoticed, until the damage done has become so serious that it is impossible to save the trees or branches affected. The adult, which is a greenish or purplish bronze beetle, 5 to 9 millimeters long, feeds on the leaf edges, leaving characteristic cuts.

Control measures.—Collecting the beetles; spraying the leaves with lead or calcium arsenate (5 to 15 grams to a liter of solution); painting the trunk with a strong lime sulphur solution, or lime sulphur sludge; cutting off and burning badly infested branches or trees are good.

The citrus leaf miner (*Phyllocnitis citrella, Stanton*).—The larva of this insect is a true leaf miner. It does considerable damage especially to the foliage of nursery plants. The injury caused by this insect is most noticeable on the weak and slow growing plants. But as no permanent injury is done by this insect it is not considered serious. A stimulation of the growth of the plants will soon make them outgrow the damage done.

Mealy bugs, scale insects, and aphids.—These three kinds of insects belong to the large group of sucking insects which are very destructive to plants.

The mealy bugs are brownish, soft-bodied insects, 2 or more millimeters long, and covered with a white, mealy substance from which they get their common name. These insects may appear on the twigs and leaves, or under the ground, feeding on the tender bark of the trunk or of the roots.

The scale insects produce a scale-like covering on their bodies, from which they derive their common name. They are mostly stationary, and they feed by inserting their beaks into the plant tissues (bark, fruit, and leaves). There are many kinds of

scales attacking citrus trees in the Philippines. Sometimes they do much damage to trees. However, on account of the presence of natural enemies, both fungi and insects, they are usually held in check.

Aphids are the so-called ant cows or plant lice. At times they become numerous, although they may rarely be considered serious because they are usually exterminated by predatory enemies, chiefly the lady bird beetles and syrphid flies, before they do very serious damage.

Control measures.—For mealy bugs and scale insects: Spraying with soap solution (450 grams Chinese soap in 20 liters boiled water) kills these insects. A sprayer with a strong pressure should be used.

For plant lice: The following spray is recommended:

Black leaf 40 (nicotine sulphate)	$\frac{3}{4}$ oz.
Soap	4 oz.
Water	4 gals.

Dissolve the soap in boiling water; add the black leaf 40 and boil for a few minutes; after which add enough water to make 4 gallons of solution.

Ants.—Many kinds of ants are troublesome in the citrus orchard. The pests sometimes do direct injury to the plants, but the greatest harm they do is the protection which they furnish to mealy bugs, scale insects and aphids, from the attacks of their natural parasites. Thus, they are indirectly very injurious.

Control measures.—For ants which nest in the ground, pour a few tablespoonsfuls of carbon bisulphide, or smaller quantities of calcium syanide into holes bored in the nest, the number depending upon the size of the nest. Care must be taken with these chemicals as they are very poisonous, both to plants and animals. The former is an explosive and highly imflammable also, so no fire should be allowed near it. These materials should not be applied close to the main roots or stems of trees, as they would cause injury.

For ants nesting on the trees: The nests may be cut off and placed over a fire or submerged in a bucket containing soap solution for a few minutes. The ants can be killed also on the trees by spraying them with soap solution. Persistent fighting and care are needed to keep ants in check.

MISCELLANEOUS TROUBLES

Loranthus philippensis (*Dapo*).—This is a common plant parasite in the Philippines. Its favorite hosts are neglected trees. Once it has started to grow on a branch, it quickly saps the vitality of that branch. This parasite is easy to eradicate if timely and persistent efforts are made to remove it from the trees.

Strong and healthy branches infested with this parasite should not be sacrificed, but it should be removed. After a thorough cleaning of a heavily infested orchard, the eradication work should be followed up at frequent intervals. A boy provided with a light, one-piece bamboo ladder (Fig. 15), may be conveniently and economically employed for this purpose. To reduce the source of infestation, wild trees growing in the neighborhood and harboring the parasite should be killed.

Lichens (*Lumut*).—Lichens are composite organisms made up of algae and fungi living together in symbiotic relationship. They often grow on the bark of citrus trees, and while they do not draw their food from the trees as does the Loranthus parasite, they indirectly injure the trees by covering the pores of their bark and hindering it from performing its functions properly. Moreover, lichens may harbor and transmit fungous diseases to the bark.

Lichens can be readily eradicated from the bark of citrus trees by spraying them with lime sulphur solution, prepared as follows: Put into an empty, 5-gallon can 2.5 gallons of water. Bring this to boiling. Drop in 2 kilos sifted flowers of sulphur and keep the mixture boiling for 15 minutes. Then add, little by little, 2 kilos of sifted lime of good quality. Keep the mixture boiling for about 20 minutes, stirring it constantly. Add more water to bring the volume of the mixture to two-third of the can. Remove from the fire. This stock solution deteriorates in the presence of air, so keep the unused solution in an air tight container.

For spraying lichens, use 1 part of the stock solution in 9 or 10 parts of water. Thoroughly wet the lichens and they will disappear in 2 or 3 months. Apply the solution with a sprayer or with a brush.

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TOP-WORKING CITRUS TREES

This is the process of changing the top of a tree for another top by means of vegetative propagation. The object of top-working is usually the growing of a desired variety in the place of a less desirable variety. Sometimes, however, an inherently weak tree, or a tree made weak by the depredations of the Loranthus parasite and of diseases, can be saved and transformed quickly into a useful tree by top-working it to a vigorous and productive variety.

Batangas mandarin trees are easily top-worked because they usually have sprouts suitable for budding. In the absence of such sprouts, however, they can be induced to grow by cutting off one or two large branches of the tree to be worked.

Well-spaced sprouts which originate at a height of from 15 to 60 centimeters above the ground should be selected for budding. After the desired buds have grown to a length of 2 or 3 feet, the top of the original trees should be pruned from time to time to gradually eliminate it while the buds worked on it are increasing in size. No sudden reduction of the original top should be made while the buds are still very small; as that would throw the circulation of sap in the tree and greatly weaken it. The original top should not be completely removed before the top-worked buds have attained stems of 2 or 3 inches in diameter. In accomplishing this, the rules for pruning should be observed.

It is important that only suitable varieties be used for top-working. Such varieties should be well adapted to the kind of tree to be worked, should be strong growers, and yield good fruit.

The following varieties are recommended for top-working Batangas mandarin trees: Tahiti lime, P. I. 5163; Siamese seedless pummelo, P. I. 3442, 3673; Marsh seedless grapefruit, P. I. 1631; Duncan grapefruit, P. I. 2687; Sampson tangelo, P. I. 1618; King mandarin, P. I. 2693; Szinkom mandarin, P. I. 1267; Ladu mandarin, P. I. 1256; Calamandarin; St. Michael orange, P. I. 1270; Laurel orange, P. I. 8858; Cuevas orange; Aguilar orange; Gonzales orange; Dougat orange, P. I. 4119; Homosassa orange, P. I. 2691; Misamis orange, P. I. 2568; Valencia orange, P. I. 2569.

PLATE I. Citrus nursery. Tanauan Citrus Experiment Station

PLATE II. A budded Pink pummelo tree. Tanauan Citrus Experiment Station

PLATE III. China mandarin tree. Tanauan Citrus Experiment Station

PLATE IV. Dancy mandarin tree. Tanauan Citrus Experiment Station

PLATE V. Szinkom mandarin tree. Tanauan Citrus Experiment Station

PLATE VI. Commercial calamondin grove. Ambulong, Tanauan, Batangas

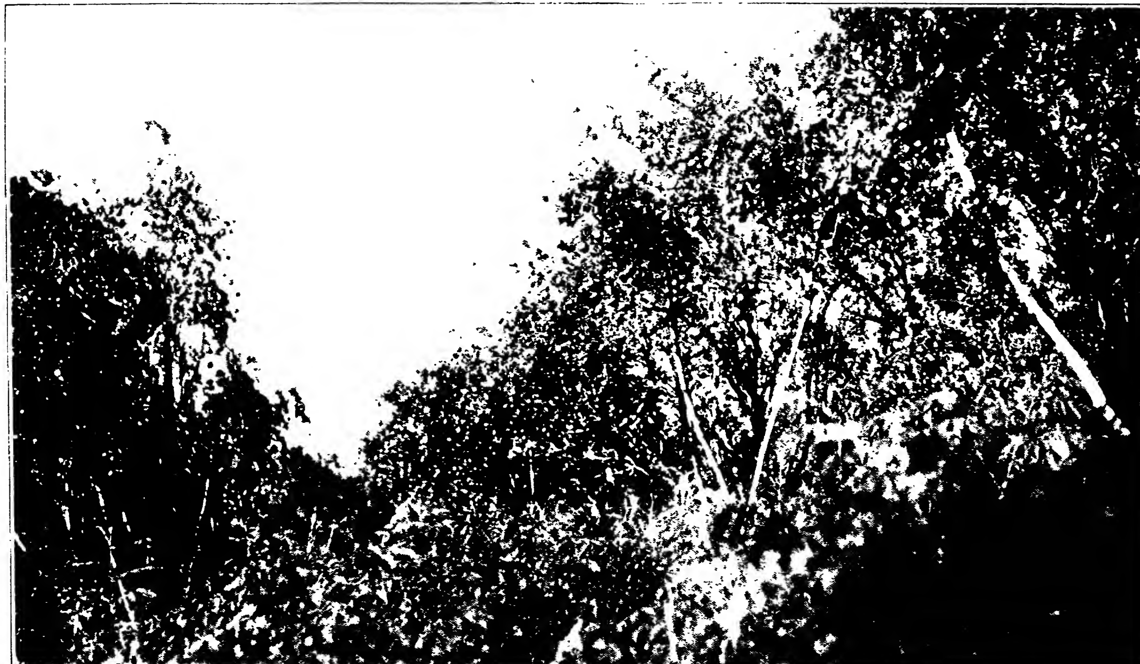

PLATE VII. Heavily loaded Batangas mandarin grove, with ipil-ipil cover crop
Tanauan Citrus Experiment Station

PLATE VIII. Propping and tying branches of heavily laden Batangas mandarin orange tree
Tanauan Citrus Experiment Station

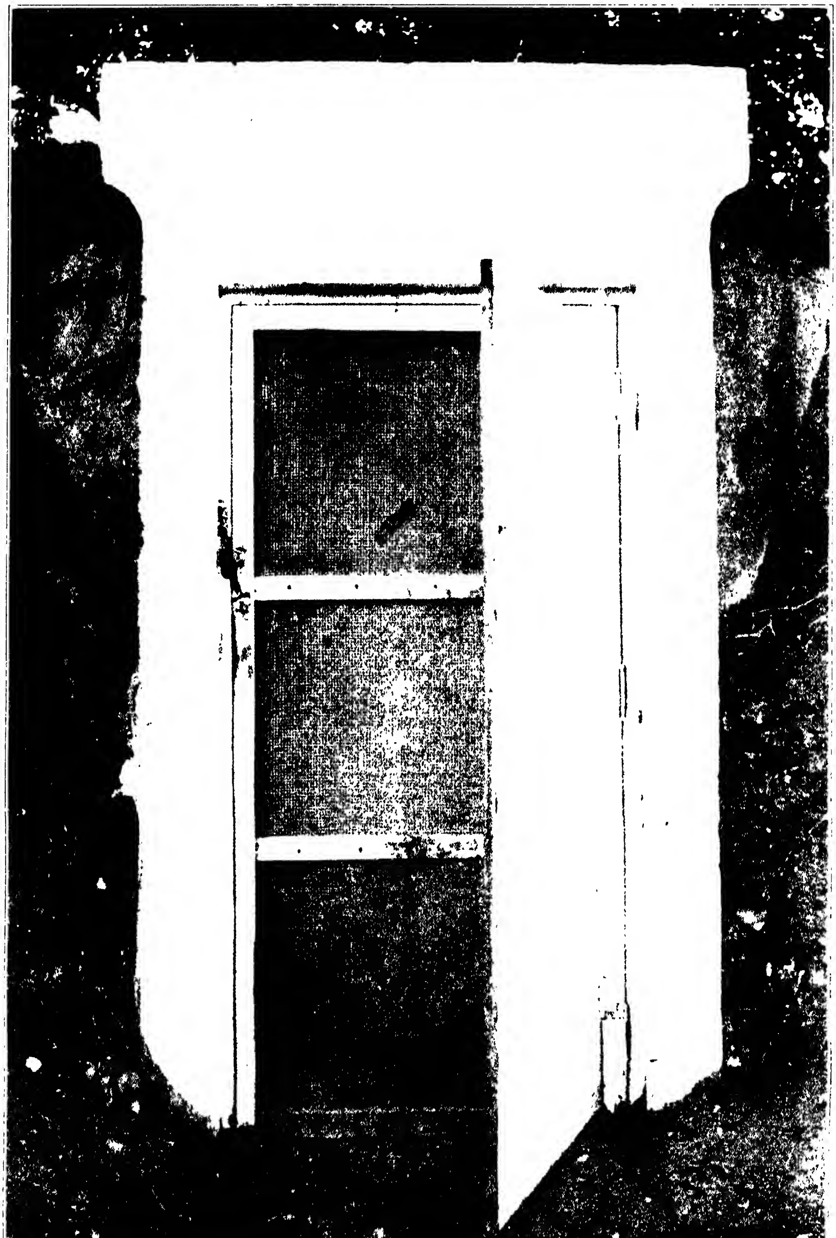

PLATE IX. Entrance to underground fruit storage chamber. Tanauan Citrus Experiment Station

PLATE X. Partial view of the interior of the underground storage chamber Tanauan Citrus Experiment Station

PLATE XI. Newly treated bark rot and old one already cured. Tanauan Citrus Experiment Station

PLATE XII. An early stage in top-working of a Batangas mandarin tree, showing 3-year-old buds in fruit. Tanauan Citrus Experiment Station

PLATE XIII. A Batangas mandarin tree completely top-worked to Siamese Seedless pummelo. Tanauan Citrus Experiment Station

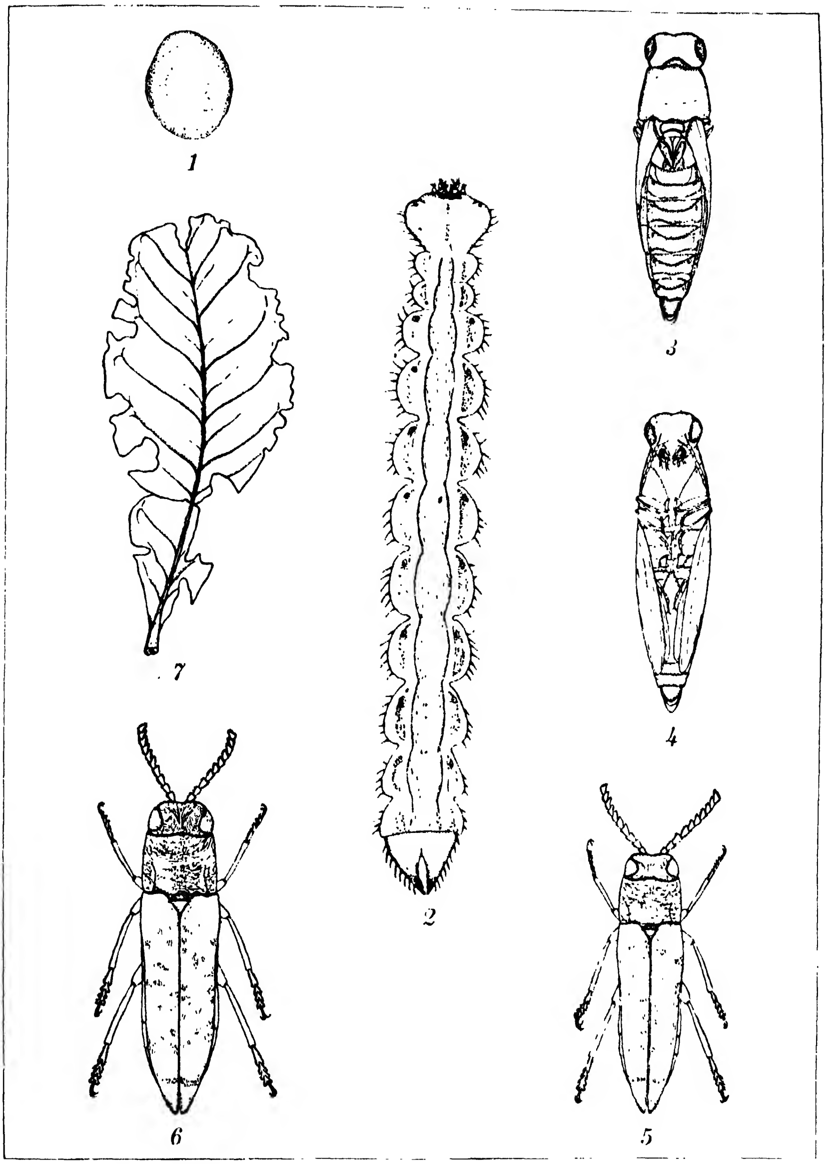

PLATE XIV. The Citrus Bark Borer (*Agrilus occipitalis*) showing different stages: (1) egg; (2) larva; (3) pupa, dorsal or back view; (4) pupa ventral or lower view; (5) adult beetle, male; (6) female; and (7) a leaf of orange showing characteristic cuts made by the bettles. All figures greatly enlarged, except No. 7 which is much reduced.

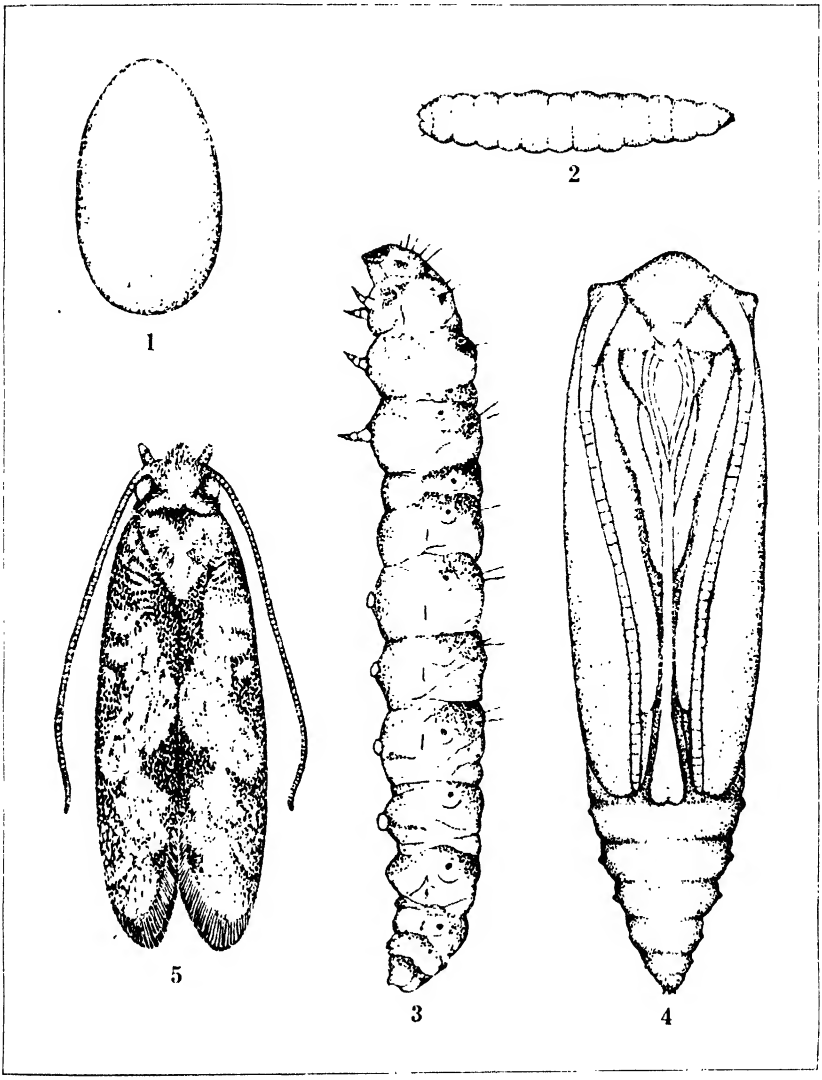

PLATE XV. The Citrus Rind Borer

PLATE XVI. Citrus fruit, leaves, and twig attacked by citrus canker

OBSERVATIONS ON THE IMPORTANT DISEASES OF CITRUS AT THE LAMAO EXPERIMENT STATION

By EMILIO K. MORADA
Assistant Horticulturist

ELEVEN TEXT FIGURES

Citrus plants are subject to several important diseases which require close supervision and attention to successfully combat. A number of these have been found affecting the citrus trees at the Lamao Experiment Station, Lamao, Bataan. Among these the bark rot and the pink diseases are so destructive that once they gain entrance into a citrus orchard, they are liable to kill the trees. About 98 per cent of the dead trees observed have died from bark rot and 2 per cent from the pink disease. The other diseases have never been found to kill any citrus trees.

Observations were started in January, 1922 and ended in December, 1924, so that altogether, there were eighteen observations made. During the observations, each tree was examined thoroughly in order to find out what diseases were present and if so, what parts were attacked, and what injury had been done. In recording the last item, the following terms were used: (1) severely attacked, (2) slightly attacked, and (3) not attacked. In order to have a more definite idea of the extent of injury, the above terms, were reduced to per cent of injury. Thy are considered as 100, 50, and 0 per cent injury, respectively.

The trees were observed for pink disease, bark rot, foot rot, canker, and mottled leaf every two months in citrus orchards A, B, and C, which were planted to different species and varieties of citrus. The trees observed had all been budded on different stocks as follows: 9 trees of *Citrus aurantifolia,* 4 of *C. aurantium,* 1 of *C. excelsa,* 2 of *C. hybrid,* 1 of *C. hystrix,* 2 of *C. limonia,* 20 of *C. maxima,* 5 of *C. medica,* 1 of *C. micrantha,* 1 of *C. miary,* 8 of *C. mitis,* 35 of *C. nobilis,* 73 of *C. sinensis,* 2 of *C. southwickii,* 3 of *C. sp.,* and 3 of *C. webberii* had been budded on *Citrus sinensis stock;* 4 trees of *C. maxima* and 1 of *C. medica* on *C. aurantium* stock; 5 trees of *C. aurantifolia,* 3 of *C. hystrix,* 1 of *C. medica,* 2 of *C. mitis,* 9 of *C. nobilis,* 10 of *C. sinensis,* 1 of *C. sp.,* and 1 of *C. webberii* on

C. mitis stock; 3 trees of *C. aurantifolia,* 5 of *C. aurantium,* 2 of *C. excelsa,* 2 of *C. hybrid,* 8 of *C. hystrix,* 2 of *C. limonia,* 24 of *C. maxima,* 1 of *C. micrantha,* 1 of *C. mitis,* 9 of *C. nobilis,* 6 of *C. sinensis,* and 9 of *C. webberii* on *C. maxima* stock; one tree of *C. aurantium,* 1 of *C. nobilis* and 1 of *C. sinensis* on *C. nobilis* stock; 2 trees of *C. sinensis* and 2 of *C. southwickii* on *C. aurantifolia* stock; 1 tree of *C. limonia,* 1 of *C. medica* and 1 of *C. sinensis* on *C. hystrix* stock; 2 trees of *C. excelsa,* 3 of *C. hystrix,* 2 of *C. longispina,* 4 of *C. mitis,* 6 of *C. nobilis,* 8 of *C. sinensis* and 2 of *C. webberii* on *C. excelsa* stock; 2 trees of *C. hystrix,* 2 of *C. maxima,* 3 of *C. nobilis,* and 4 of *C. sinensis* on *C. webberii* stock; 2 trees of *C. maxima* on *C. macrophylla* stock; and 1 tree of *C. maxima* on *C. sp.* stock. They ranged from 2 to 13 years old from transplanting and were planted 8 by 4 meters apart.

The actual and the individual tree observations are not given in detail in this article because they are too voluminous, but instead only the summary giving the results by species and varieties is given in brief, as it is accurate enough to form a definite conclusion.

Some species of citrus, like *C. micrantha, C. miary,* and *C. southwickii* were represented by so very few trees that the actual results as to these species should not be taken as final.

All the aforementioned diseases appeared during the three-year period of observation, although in the third year the diseases were not so destructive as in the first year, because of the orchard sanitation practiced. Some of the diseases became virulent during some parts of the year while others appeared only in mild form. They were dormant in certain seasons and when favorable conditions for their growth existed they appeared at once and spread rapidly. The trees did not die from these diseases at first but the successive attacks weakened their vitality, as a result of which they died gradually. Different citrus species and even varieties under each species exhibited different degrees of susceptibility to the various citrus diseases. Their destructiveness to a great extent depended on the season and the species of citrus affected.

Bark rot.—Bark rot is the most destructive disease of citrus, occurring generally on the trunk and branches (Fig. 10). The cause of this disease is unknown. It appears as slightly raised cracked portions of the bark from which usually a brownish,

gummy substance oozes. This substance is somewhat sticky in the morning and as the heat of the sun increases it becomes hard. In the new state, the bark appears to be watery or oily, but later on it cracks and the gum oozes out. The disease soon spreads out and encircles the parts attacked. The cracks become from one to sometimes ten centimeters long, and from 3 to 10 millimeters wide, and the amount of gum increases also. The disease extends only to the wood. The wood under the diseased bark is slightly brownish in color thus characterizing the presence of dead cells. The diseased portion emits a disagreeable odor. This kind of exudation is the most common, appearing in the pummelo, orange, lemon, lime, citron, lemon real, calpi, cabuyao, and tamisan.

On the mandarin, (*citrus nobilis*) the mode of attack is more or less different. Sometimes the disease can not be recognized during its early stage as no cracking of the bark and oozing of the gum occur except during the latter stage of its development, as a result of which the leaves turn yellow at once. A foul odor is given off due to the fermentation of the gum. This peculiar odor attracts several insects and thus the affected parts become their feeding and breeding places.

Thirteen trees at Lamao in 1922 died of bark rot, 7 in 1923 and 27 in 1924. The many deaths in 1924 were due to the flood of November, 1923, which washed off the surface soil and part of the subsoil of the orchards, thereby destroying and exposing to the air and sun many of the roots, lessening the vitality of the trees. The disease appeared mostly in the dry season and was almost unnoticeable during the rainy season. At this time of the year, the trees resisted the disease because of their vigorous growth while during the dry season or when the trees were in a dormant condition the development of the bark rot was very rapid.

Different species and even varieties within the species exhibit different degrees of resistance to the disease. The resistant varieties are given in Table I, and the species in the order of thir resistance to bark rot are ranked in Table IV.

Carbolineum was tried both at this station and at the Tanauan Citrus Experiment Station for treating the disease and the results so far obtained have been encouraging. Parallel and crosswise cuts about 3 millimeters wide and reaching to the wood were made in the diseased portions. The carbolineum

was then applied with a small paint brush. The main advantage of this treatment is that it is effective and at the same time callousing takes place easily.

Table V gives the results of the carbolineum treatment. All the diseased trees in citrus orchards A, B, and C were treated with carbolineum. The severely diseased trees, though, died in spite of the application of carbolineum, but those only slightly affected recovered easily. The badly affected trees were dug up and burnt to prevent infection of the sound trees.

Taking the average for all the trees treated, a total expenditure of forty centavos (₱0.40) per tree was incurred.

In one case where the bark rot occurred at the base of the trunk near the ground and extended to the junction of the trunk and root system, which prevented the easy manipulation of the carbolineum treatment, a mound of moist earth was piled at the base of the trunk after the affected parts had been thoroughly cleaned so as to induce the formation of a new root system on that portion of the trunk, and at the same time the crown of the trees was partly pruned to lessen the transpiration from the leaves. In a month or so new roots came out from the callousing bark in the mound of soil, thereby establishing another root system above the diseased trunk which performed the work of the affected roots.

Pink disease.—The pink disease, caused by *Corticium salmonicolor* Berk et Broome, is sometimes associated with bark rot but very often it attacks the tree alone. In the latter case no cracking of the bark and exudation of the brownish fluid take place, but a network of mycelium is seen on the bark encircling the affected part of the tree (Fig. 9). It is quite difficult to recognize the disease during its early stage as the network of mycelium from a distance looks like the white superficial fungus which are often seen on the trunks and branches of citrus trees. But if a closer examination is made, one will find this network has characteristics which distinguish it from the fungus.

In the latter stage of the disease, the fungus penetrates through the bark and into the wood, which causes the rotting and drying up of the bark. Then the mycelium forms into the irregular pink lines or patches, from which the disease derives its name. As the disease advances the leaves turn yellow and fall off. The yellowing of the leaves of an entire branch is an indication of the presence of pink disease in a severe form.

The pink disease appears on many varieties of plants and mostly during the rainy season. In the dry season it is dormant

but when the favorable season exists it spreads rapidly and becomes very destructive to plants. The affected part of a citrus tree is sure to die unless prompt attention is given to curing the disease. In 1922, five cases of pink disease were observed on *C. aurantifolia*, *C. maxima*, and *C. sinensis;* four in 1923 on *C. aurantifolia*, *C. nobilis*, and *C. sinensis;* and eleven in 1924 on *C. aurantifolia*, *C. hybrid*, *C. hystrix*, *C. mitis*, *C. nobilis*, and *C. sinensis*. Although no trees died entirely from this disease the portions attacked were killed.

The different species in which it was never found during the period of observations are *C. aurantium*, *C. webberii*, *C. limonia*, *C. longispina*, *C. medica*, *C. micrantha*, *C. miary*, *C. southwickii*, and *C. species*.

No definite remedy has been found for the disease when it reaches the advanced stage except the collection and burning of all diseased parts. The healthy parts are cut into and the wounds disinfected with a 5 per cent formaldehyde solution and then coated with white lead paint to avoid the attack of other organisms. In the early stage of the disease when the mycelium has not yet penetrated the bark, washing the diseased portion with a 5 per cent formaldehyde solution was found to be effective at Lamao.

Canker.—Canker caused by a bacterium known as *Pseudomonas citri* Hasse affects all parts of its hosts, except the roots, trunk, and branches. On the leaves the disease, when it first appears (Figs. 1 and 3), is characterized by small, watery, round, brown, and slightly raised spots either on the upper or lower surfaces of the leaves or on both. In the early stage that portion which surrounds the spots is watery; but later on, as the spots enlarge, the surfaces become ruptured. In some species and varieties of citrus, as for instance in some grapefruits, the spots are surrounded by watery black portions. These are more distinct on the upper than on the lower surfaces of the leaves. The spots may run together and in many cases the leaf miner (Fig. 2), is the chief agent in spreading the disease. The spots penetrate from the upper to the lower surfaces of the leaves, and in the majority of cases they are more distinct at the upper than at the lower surfaces.

On the twigs (Fig. 4) the spots are brownish in color, spongy and raised, with more or less watery borders in the new stages. The spots extend more or less through the outer layer of the bark only, and they may run around the twig.

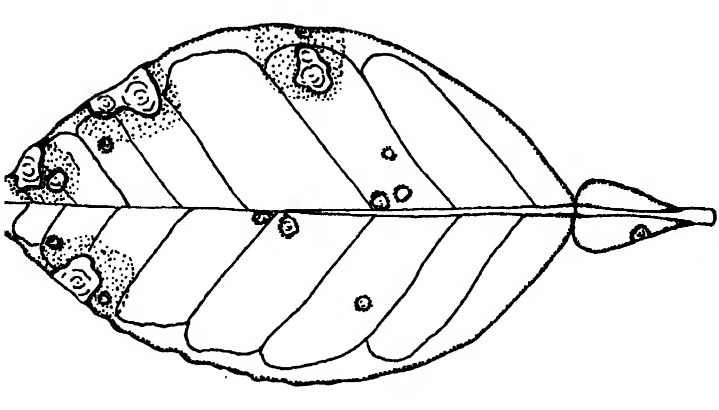

FIG. 1. Canker on a pummelo leaf with yellow surroundings.

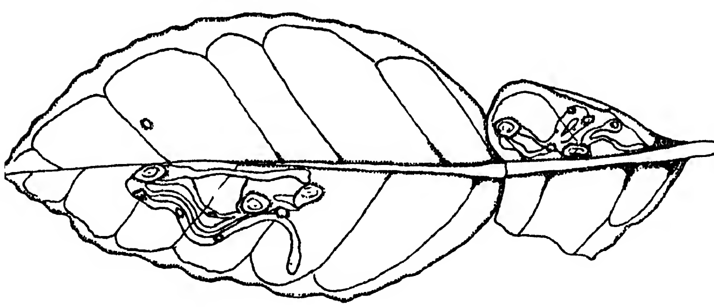

FIG. 2. Leaf miner on a pummelo leaf spreading canker.

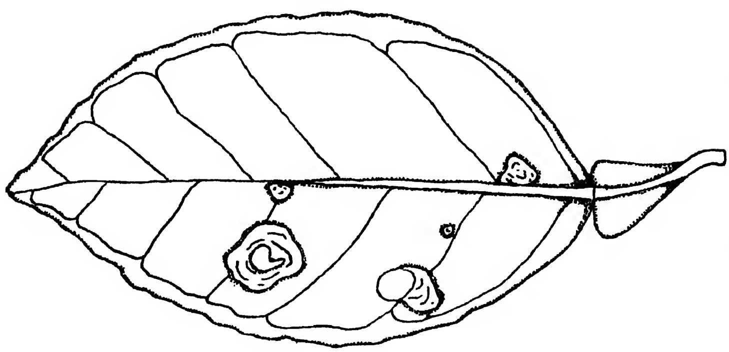

FIG. 3. Old stage of canker on a pumme leaf with holes at center.

On the fruits (Fig. 5) the spots are similar to those on the leaves. They are irregular, brownish and raised spots which may run together to form big irregular blotches. The canker does not penetrate deeply into the inside portion of the fruit so that it merely spoils the look of the fruits and does not injure the pulp and flavor. In most cases the diseased portions are depressed. Sometimes gumming of the fruits (Fig. 6), occurs due to this disease.

Canker is a disease affecting citrus plants and under natural conditions it affects all the citrus species excepting *C. nobilis*, *C. mitis* and Kumquat, *Fortunella japonica*. At Lamao citrus canker affects the trees at all seasons but in some cases spreads rapidly during the rainy season because of the many tender growths and the favorable climate for its development. However it appears more destructive in the dry season than in the rainy season due to the low vitality of the trees. No new growths are produced while the disease continues to spread although it does so much more slowly than in the wet season. Citrus trees within the radius of its attack do not suffer as much from it as from the bark rot. The extent of injury varies with the different species and varieties. So far no trees have died from this disease at the station.

The canker-resistant varieties under each species are given in Table I and the species in the order of their resistance to this disease are in Table VI.

The best preventive measure for the disease is Bordeaux mixture or lime sulphur spray applied before and after the rainy season. The latter has an advantage over the other in that it kills the fungus, aphids and scale insects, while the first one kills only the fungus. All badly diseased parts should be cut away and burned to lessen infection.

Foot-rot.—Foot-rot (Fig. 11) is an unknown disease more or less similar to bark rot, except that it occurs only at the roots and on the lower trunk not more than a foot from the ground while the bark rot appears all over the trunk and branches of the trees. At first the bark begins to decay and the gum comes out. Later on the rotting of the bark extends downward, which development is followed by the decaying of the woody portion of the root.

As the disease appears only on the roots and on the lower part of the trunk, observations were only taken from the visible portions during this investigation. Possibly, therefore many affected trees were not noticed. Seven cases of foot rot were

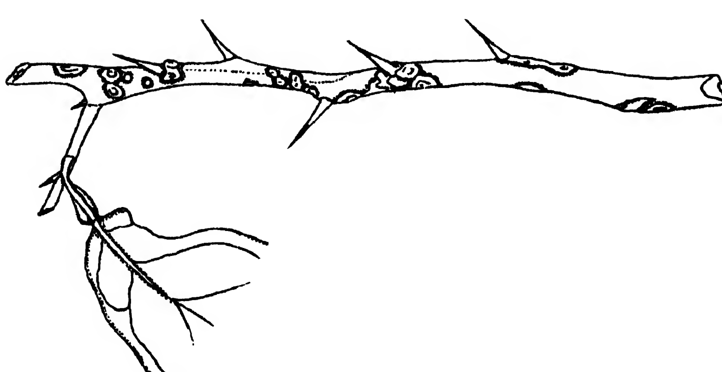

FIG. 4. Canker on a twig of lime.

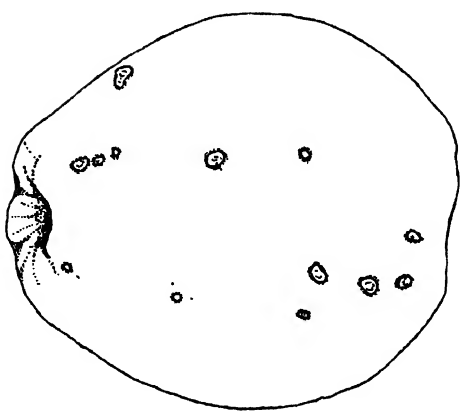

FIG. 5. Canker on a grapefruit.

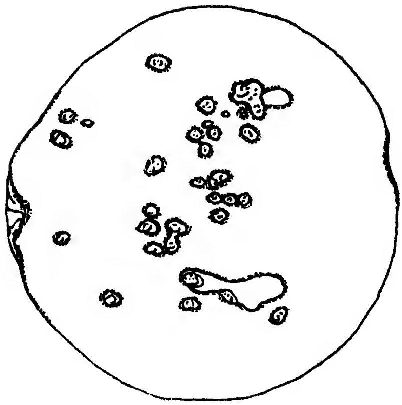

FIG. 6. Gumming due to canker on a grapefruit.

observed in 1922, one in 1923 and six in 1924 on *C. aurantium*, *C. medica*, *C. sinensis*, *C. webberii*, *C. aurantifolia*, *C. hybrid*, and *C. hystrix*. The disease has not been serious so far at Lamao, and no trees have died from it.

No definite remedy has been discovered yet. Treatment of the disease is quite a difficult matter because the parts attacked are under the ground and to dig up the roots is detrimental to the plants. Some recommend the exposure of the affected roots to the sun for several days before they are again covered with the soil but this was not tried lest it kill the trees affected.

Mottled leaf.—Mottled leaf (Figs. 7 and 8) is characterized by the yellowing of the mesophyll or the parts of the leaves between the midrib and the lateral veins. The parts adjacent to them remain green.

Mottled leaf, as observed, may be an abnormality inherent to the plants. That is, one or more important elements necessary to the normal development of the plants may be lacking, or they may be present in only such insufficient quantities as to cause the yellowing of part or the entire mesophyll of the leaves.

Mottled leaf affects the trees throughout the year in varying degrees. Its attacks are influenced by the season but mainly by the species and varieties of citrus. It was not found on *C. aurantifolia*; *C. excelsa*, *C. limonia*, *C. medica*, and *C. southwickii* during the course of the observations. Table I shows the varieties resistant to mottled leaf under each species. The species of citrus which are more or less susceptible, in the order of their enumeration, are given in Table VII.

From the observations in Table VII it seems that mottled leaf is more or less a physiological character. The orchards used received the same treatment as to cultivation and irrigation, and they are well drained, so that the ail mottled leaf is not due to any improper care of the orchards. It may however, be the result of unbalanced nutrition, for trees of the different varieties of the same species planted at different places and varying in their vegetative growths did not exhibit it.

RECOMMENDATIONS

1. Because of their resistance to bark rot, the most destructive disease of citrus at Lamao, *C. aurantium*, *C. mitis*, and *C. species* are recommended for stock purposes.

2. The varieties recommended for scions are on *C. aurantifolia*, the Tahiti and the Trinidad limes; on *C. maxima*, the Sia-

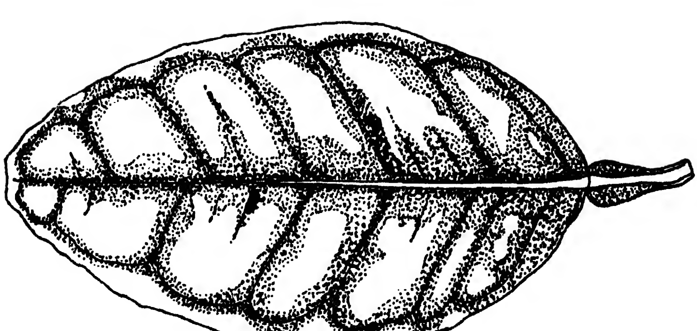

FIG. 7. Mottled leaf of orange.

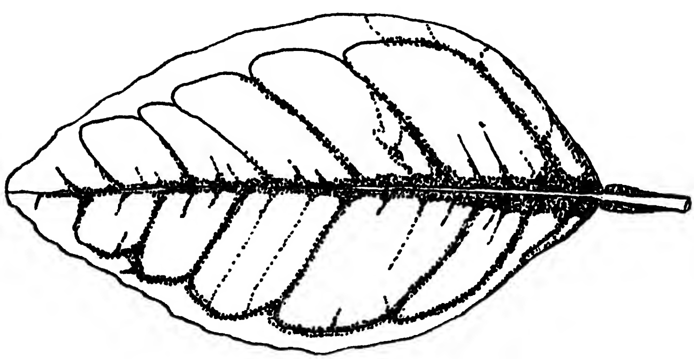

FIG. 8. Mottled leaf of orange.

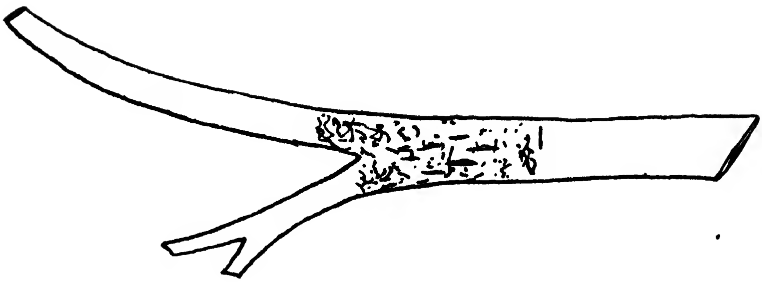

FIG. 9. A branch of an orange tree attacked by pink disease.

mese pummelo; on *C. nobilis* the Ubay and the China mandarins; and on *C. sinensis*, the Majorca orange.

3. Carbolineum is likewise recommended for treating the trees slightly affected with bark-rot.

4. That an extensive campaign to teach the proper culture of citrus orchards together with orchard sanitation and the most practical methods of treating the diseases, including the use of

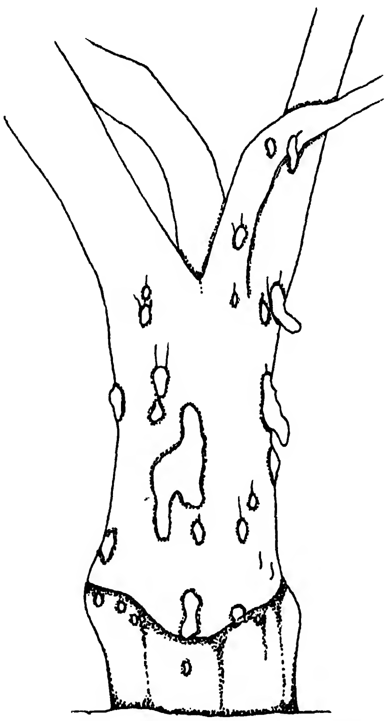

FIG. 10. Trunk of a Citron tree affected with bark rot.

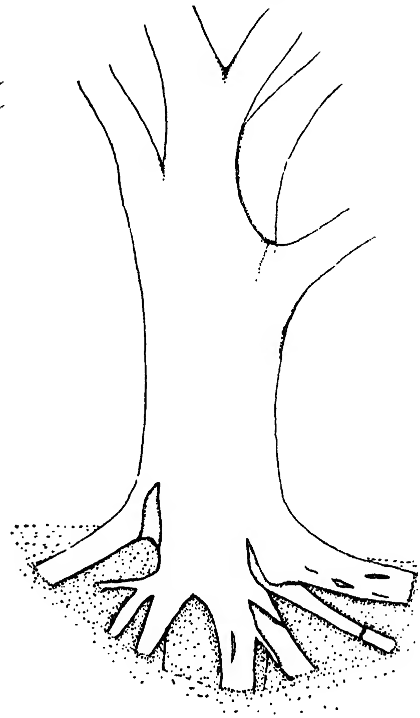

FIG. 11. Roots of an orange tree affected with foot rot.

the resistant varieties, be undertaken in the provinces where citrus growing is an important industry in order to eradicate the diseases. The methods to be followed in combating and preventing citrus diseases may be described in brief as follows:

(*a*) Soil treatment.

(*b*) Spraying the trees with Bordeaux mixture or lime sulphur in order to kill or prevent the germination of spores.

(*c*) Removing the diseased parts and burning.

(*d*) Preventing conditions favorable for their growth, such as weakened condition of the trees, injury and others.

(*e*) Planting the disease-resistant varieties as before.

(*f*) Importing plants only from disease-free localities or countries.

5. And that a vigorous campaign be made to topwork all inferior and unproductive citrus trees to good and productive varieties of citrus.

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(2) REINKING, OTTO A., Philippine Economic Plant Diseases, Philippine Journal of Science, Vols. 4 and 5, pp. 184–192.

(3) REINKING, OTTO A., Citrus Diseases of the Orient, the Philippine Agriculturist, Vol. IX Nos. 6–7, Jan.–Feb. 1921, pp. 122–138.

(4) WESTER, P. J., Citriculture in the Philippines, Bulletin No. 27. 1923.

(5) The Philippine Agricultural Review, Vol. XVI, No. 3. 1923.

TABLE I.—*Showing the citrus varieties resistant to the diseases*

P. I. No.	Variety name	Kind of stock[1]	Pink disease: Extent of infection 1922	1923	1924	Average per cent of infection
	Citrus aurantifolia					
2182	Lime	O	None	None	None	0
1749	Mindoro lime	O	do	do	do	0
901	Dayap	O	do	do	do	0
902	Do.	O	do	do	do	0
3670	Trinidad	Cn	do	do	Slight	16 66
5163	Tahiti	O	do	do	None	0
5176	Lime	P&Cn	do	do	do	0
4827	Lombog	P	do	do	do	0
3669	Everglade	Cn	Slight	Slight	Severe	66.66
5184	Kusaie	P	None	None	None	0
	Citrus aurantium					
1264	Florida orange	P&M	None	do	do	0
1638	Sour orange	O	do	do	do	0
2511	Florida orange	O	do	do	do	0
2662	Sour orange	P	do	do	do	0
2385	Do.		do	do	do	0
	Citrus excelsa					
833	Lemon real	P	Died			
835	Chinese lemon	O	do			
1009	Lemon real	Stock	None	None	None	0
3388	Le Nestour	Lr	do	do	Died	0
3665	Lemon real	Lr	do	do	do	0
3841	Tanchan	P	Slight	do	do	25.00
	Citrus hybrid					
1948	Sampson		None	do	None	0
1618	Do.	O	do	do	do	0
1385	Do.	P	do	do	do	0
	Citrus hystrix					
2535	Colo-colo	Cn	do	do	do	0
3668	C. hystrix	Cn	do	do	Severe	33.33
3656	Canci	Lr	do	do	None	0
3665	Colobot	P	do	do	do	0
2494	Cabuyao	O	do	do	do	0
5165	Suangui	A	do	do	do	0
4214	Camugao	Lr	do	do	do	0
4225	Calooy	Lr	do	do	do	0
4824	Canci	P	do	do	do	0
4830	Amontay	P	do	do	do	0
5187	Colobot	P	do	do	do	0
5189	Cabuyao	P	do	do	do	0
6539	Duroga		do	do	do	0

[1] O=Sweet orange; P=Pummelo; Cn=Calamondin; SO=Sour orange; Lr=Lemon real; Le=Lime; Cw=*Citrus webberri;* M=Mandarin; K=Kabuyao; Csp=*Citrus sp.;* and Cmac =Citrus macrophylla.

TABLE I.—*Showing the citrus varieties resistant to the diseases*—Continued

P. I. No.	Variety name	Kind of stock[1]	Pink disease: Extent of infection 1922	1923	1924	Average per cent of infection
	Citrus limonia					
708	Lisbon	P	None	None	None	0
1712	Thornless	O	Died			
1704	Bengal	O	do			
4804	C. limonia	P	None	None	Died	0
5175	Do	K	do	do	None	0
	Rough lemon		do	do	do	0
	Citrus longispina					
3658	Camisan	Lr	do	do	do	0
4839	Tamisan	P	do	do	do	0
4840	Do	P	do	do	do	0
	Citrus macrophylla					
4820	Alemow	P	do	do	do	0
	Citrus maxima					
2265	Lukban	O	do	do	do	0
1713	Triumph	O	do	do	do	0
1707	Marsh	O	do	do	do	0
1633	Case	O	do	do	do	0
1631	Marsh	O	do	do	do	0
1632	Triumph	O	do	do	do	0
1334	Pernambuco	O&Csp	do	do	do	0
1333	Ellen	O	do	do	do	0
891	Pomelo	O	do	do	do	0
893	Do	O	do	do	do	0
899	Do	O	do	do	do	0
5181	Do	P	do	do	do	0
2700	McCarthy	P	do	do	do	0
1995	Siamese	P	do	do	do	0
2687	Duncan	P	do	do	do	0
2690	Marsh		do	do	do	0
3882	McCarthy	SO	do	do	do	0
	Jolo pomelo		do	do	do	0
3389	Siamese	P	do	do	do	0
4118	Walter	SO&O	do	do	do	0
4121	McCarthy	Cw	do	do	Slight	16.66
4125	Royal	Cmac	do	do	None	0
2524	Pomelo	P	do	do	do	0
3678	Siamese	O	do	do	do	0
5152	Do	P	do	do	do	0
3392	Do	P	do	do	do	0
3391	Do	P	do	do	do	0
2503	Boongone	O	do	do	do	0
3442	Siamese	SO	do	do	do	0
3876	Nakoin	P	do	do	do	0
5103	Panuban	P	do	do	do	0
4868	Kellogg	P	do	do	do	0
5144	Panuban	P	do	do	do	0
5146	Do	P	do	do	do	0
5523	Pomelo	P	do	do	do	0
3384	Saigon	P	Slight	Slight	do	33.33
	Citrus medica					
2183	Citron	O	None	None	None	0
1716	Do	O	do	do	do	0
848	Merrill	O	do	do	do	0
4739	Pesak	SO	do	do	do	0
4826	Cidra	Cn	do	do	do	0
2264	Tambuyog	K	do	do	do	0
	Citrus miary					
6589	C. miary		do	do	do	0
	Citrus micrantha					
2502	Biasong	O	do	do	do	0
4821	Samuyao	P	do	Died		0

[1] O=Sweet orange; P=Pummelo; Cn=Calamondin; SO=Sour orange; Lr=Lemon real; Le=Lime; Cw=*Citrus webberri;* M=Mandarin; K=Kabuyao; Csp=*Citrus sp.;* and Cmac =Citrus macrophylla.

TABLE I.—*Showing the citrus varieties resistant to the diseases*—Continued

P. I. No.	Variety name	Kind of stock [1]	Pink disease: Extent of infection 1922	1923	1924	Average per cent of infection
	Citrus mitis					
1718	C. mitis	O	None	None	Died	0
2355	Calamondin	P	do	do	None	0
2513	Do	Lr	do	do	Slight	16.66
2332	Do	Lr	do	do	None	0
2534	Do	Cn	do	do	do	0
	Citrus nobilis					
1265	China	Cw	do	do	do	0
1271	Kishiu	O	do	do	Slight	16.66
1272	Konda Narum	O&Cn	do	do	None	0
1918	Dancy	------	do	do	do	0
1335	Oneco	O&Cn	do	do	do	0
1256	Ladu	Lr	do	do	do	0
744	Tizon	O	do	do	do	0
745	Do	Lr	do	do	do	0
2693	King	P	do	do	do	0
1276	Suntara Nagpur	Lr	do	Died	------	0
5173	Saagkam	Cn	do	do	------	0
3383	Madurensis	Lr	do	do	------	0
1262	Suntara	P	do	do	------	0
2984	Chinese	P&M	do	do	------	0
5142	Laurel	P	do	do	------	0
3883	Oneco	Cw	do	do	------	0
4828	Narangita	P	do	None	None	0
5138	Malvar	Cn	do	do	do	0
3139	Ubay	Cn	do	do	do	0
	Citrus sinensis					
1743	Mediterranean	Cw	do	do	do	0
1277	Seville	O	do	do	do	0
1742	Navelencia	m	do	do	do	0
1260	Excelsior	Lr&O	do	do	do	0
2685	Everbearing	Cw	do	do	do	0
2365	Orange	K	do	do	do	0
1270	St. Michael	O	do	do	do	0
1728	Cuyo	O	do	do	do	0
56	Jappa	O	do	do	do	0
1714	Larrantha	O	do	do	do	0
1715	White Siletta	O	do	do	do	0
1719	Jaffa	O	do	do	do	0
1720	Bahia	O	do	do	do	0
1705	Mediterranean	Lr&O	do	do	do	0
1706	Valencia	O	do	Slight	Slight	33.33
1711	Washington Navel	O	do	None	None	0
1639	Ruby	O	do	do	do	0
1635	Pineapple	O	do	do	Slight	16.66
1637	Jaffa	O	do	do	None	0
966	Cajel	O	do	do	do	0
51	Valencia	Cn	do	do	do	0
51	Do	O	do	do	do	0
2568	Misamis	Lr	do	do	Severe	33.33
2569	Valencia	Cn	do	do	Slight	16.66
2686	Pineapple	Cn	do	do	None	0
2694	Majorca	Lr	do	do	do	0
2697	Maltese Blood	P	do	do	do	0
2695	Brown	Lr	do	do	Slight	16.66
2689	Enterprise	------	do	do	None	0
3886	Du Roi	SO	do	do	Died	0
3660	Balanga	Cn	do	do	Slight	16.66
4117	Brown	O	do	do	None	0
5119	Dugat	Le&Cw	do	do	Slight	16.66
4120	Du Roi	Le	do	Died	------	0
4123	Magnum bonum	O	do	None	Slight	16.66
5177	Pongkan	Cn	do	Slight	do	33.33
1259	Maltese Blood	Lr	do	Uprooted	by flood	0
2698	Boone	Cn	do	None	None	0
1258	Jaffa	O	do	do	do	0
4126	Foster	O	do	do	do	0
1266	Whitaker	P&Cn	do	do	do	0

[1] O=Sweet orange; P=Pummelo; Cn=Calamondin; SO=Sour orange; Lr=Lemon real; Le=Lime; Cw=*Citrus webberri;* M=Mandarin; K=Kabuyao; Csp=*Citrus sp.;* and Cmac =Citrus macrophylla.

TABLE I.—*Showing the citrus varieties resistant to the diseases*—Continued

P. I. No.	Variety name	Kind of stock [1]	Pink disease Extent of infection 1922	1923	1924	Average per cent of infection
	Citrus sinensis—Continued					
5188	Orange	P	None	None	None	0
5522	Do	P	do	do	do	0
1701	Holdfast	O	Slight	Slight	do	33.33
4124	Carleton	O	do	None	Slight	33.33
1636	Washington Navel	O	Severe	do	None	33.33
	Citrus southwickii					
2049	C. southwickii	Le	None	do	Died	0
	Citrus sp.					
1273	Natsu dai-dai	O	None	None	None	0
3671	C. sp.	Cn	do	do	do	0
	Citrus webberri					
2266	Cabugao Igorot	O	do	do	do	0
896	Alsem	O	do	do	do	0
853	Do	Lr	do	do	do	0
4828	C. webberri	P	do	do	do	0
5102	Lias	P&Cn	do	do	do	0
5105	Alsem	P	do	do	do	0
5540	Lurad	P	do	do	do	0
5497	Ganid	P	do	do	do	0
5174	C. webberri	P	do	do	do	0

P. I. No.	Variety name	Kind of stock [1]	Bark rot Extent of infection 1922	1923	1924	Average per cent of infection
	Citrus aurantifolia					
2182	Lime	O	Slight	Severe	Slight	66.66
1749	Mindoro lime	O	do	do	Severe	83.33
901	Dayap	O	do	do	Slight	66.66
902	Do	O	do	do	do	66.66
3670	Trinidad	Cn	Severe	Slight	do	66.66
5163	Tahiti	O	None	None	None	0
5176	Lime	P&Cn	Slight	Slight	Slight	50.00
4827	Lombog	P	None	do	Severe	50.00
3669	Everglade	Cn	Severe	Severe	do	100.00
5184	Kusaie	P	None	None	Slight	16.66
	Citrus aurantium					
1264	Florida orange	P&M	do	do	None	0
1638	Sour orange	O	do	Slight	Slight	33.33
2511	Florida orange	O	do	None	None	0
2662	Sour orange	P	Slight	do	Slight	33.33
2385	Do		None	do	None	0
	Citrus excelsa					
833	Lemon real	P				
835	Chinese lemon	O				
1009	Lemon real	Stock	None	Slight	Slight	33.33
3388	Le Nestour	Lr	Slight	do	Died	50.00
3665	Lemon real	Lr	None	do	do	25.00
3841	Tanchan	P	do	Severe	Severe	66.66
	Citrus hybrid					
1948	Sampson		Slight	Slight	Slight	50.00
1618	Do	O	do	Severe	do	66.66
1385	Do	P	None	Slight	do	33.33

[1] O=Sweet orange; P=Pummelo; Cn=Calamondin; SO=Sour orange; Lr=Lemon real; Le=Lime; Cw=*Citrus webberri;* M=Mandarin; K=Kabuyao; Csp=*Citrus sp.;* and Cmac =Citrus macrophylla.

TABLE I.—*Showing the citrus varieties resistant to the diseases*—Continued

P. I. No.	Variety name	Kind of stock[1]	Bark rot: Extent of infection 1922	1923	1924	Average per cent of infection
	Citrus hystrix					
2535	Colo-colo	Cn	None	Severe	Severe	66.66
3668	C. hystrix	Cn	Slight	Slight	Slight	50.00
3656	Canci	Lr	None	None	None	0
3665	Colobot	P	do	Slight	do	16.66
2494	Cabuyao	O	do	None	do	0
5165	Suangui	A	Slight	Severe	do	50.00
4214	Camugao	Lr	None	None	Slight	16.66
4225	Calooy	Lr	do	do	do	16.66
4824	Canci	P	do	Slight	do	33.33
4830	Amontay	P	do	None	None	0
5137	Colobot	P	do	do	Slight	16.66
6189	Cabuyao	P	do	do	None	0
5539	Duroga		do	do	Slight	16.66
	Citrus limonia					
708	Lisbon	P	Severe	Slight	Slight	66.66
1712	Thornless	O	Died			
1704	Bengal	O	do			
4804	C. limonia	P	Slight	Slight	Died	50.00
5175	Do	K	None	None	Slight	16.66
	Rough lemon		Severe	Severe	do	83.33
	Citrus longispina					
3658	Camisan	Lr	Slight	None	Severe	50.00
4839	Tamisan	P	do	do	Slight	33.33
4840	Do	P	None	do	do	16.66
	Citrus macrophylla					
4820	Alemow	P	Slight	Slight	do	50.00
	Citrus maxima					
2265	Lukban	O	Severe	do	do	66.66
1713	Triumph	O	Slight	do	Severe	66.66
1707	Marsh	O	do	do	Slight	50.00
1633	Case	O	Severe	None	do	50.00
1631	Marsh	O	do	Slight	do	66.66
1632	Triumph	O	Slight	do	do	50.00
1334	Pernambuco	O&Csp	do	do	Severe	66.66
1333	Ellen	O	do	do	Slight	50.00
891	Pomelo	O	None	None	Slight	16.66
893	Do	O	do	Slight	do	33.33
899	Do	O	Slight	do	do	50.00
5181	Do	P	do	None	None	16.66
2700	McCarthy	P	None	do	do	0
1995	Siamese	P	Slight	do	do	16.66
2687	Duncan	P	do	do	do	16.66
2690	Marsh		None	do	Severe	33.33
3882	McCarthy	SO	Slight	do	do	50.00
	Jolo pomelo		do	do	None	16.66
3389	Siamese	P	None	do	do	0
4118	Walter	SO&O	Slight	Slight	Slight	50.00
4121	McCarthy	Cw	None	None	do	16.66
4125	Royal	Cmac	Severe	Severe	Severe	100.00
2524	Pomelo	P	None	None	None	0
3678	Siamese	O	do	do	do	0
5152	Do	P	do	do	Slight	16.66
3392	Do	P	do	do	None	0
3391	Do	P	Slight	do	do	16.66
2503	Boongone	O	None	do	Slight	16.66
3442	Siamese	SO	do	do	do	16.66
3876	Nakoin	P	do	do	do	16.66
5103	Panuban	P	do	do	None	0
4868	Kellogg	P	do	Slight	Slight	33.33
5144	Panuban	P	do	do	None	16.66
5146	Do	P	do	do	do	16.66
5523	Pomelo	P	do	None	Slight	16.66
3384	Saigon	P	Slight	Slight	Severe	66.69

[1] O=Sweet orange; P=Pummelo; Cn=Calamondin; SO=Sour orange; Lr=Lemon real; Le=Lime; Cw=*Citrus webberri;* M=Mandarin; K=Kabuyao; Csp=*Citrus sp.;* and Cmac = Citrus macrophylla.

TABLE I.—*Showing the citrus varieties resistant to the diseases*—Continued

P. I. No.	Variety name	Kind of stock [1]	Bark rot: Extent of infection 1922	1923	1924	Average per cent of infection
	Citrus medica					
2183	Citron	O	Severe	Severe	Slight	83.33
1716	Do	O	do	do	Severe	100.00
848	Merrill	O	do	do	do	100.00
4739	Pesak	SO	Slight	do	Died	75.00
4826	Cidra	Cn	Severe	do	do	100.00
2264	Tambuyog	K	None	None	None	0
	Citrus miary					
6589	C. miary		do	do	Slight	16.66
	Citrus micrantha					
2502	Biasong	O	Slight	do	None	16.66
4821	Samuyao	P	do			50.00
	Citrus mitis					
1718	C. mitis	O	None	Severe	Died	50.00
2355	Calamondin	P	do	None	None	0
2513	Do	Lr	Severe	do	Slight	50.00
2332	Do	Lr	None	do	Severe	33.33
2534	Do	Cn	do	do	Slight	16.66
	Citrus nobilis					
1265	China	Cw	do	do	None	0
1271	Kishiu	O	Slight	do	do	16.66
1272	Konda Narum	O&Cn	do	do	Slight	33.33
1918	Dancy		None	Slight	do	33.33
1335	Oneco	O&Cn	do	Severe	do	50.00
1256	Ladu	Lr	do	None	do	16.66
744	Tizon	O	do	do	do	16.66
745	Do	Lr	do	do	do	16.66
2693	King	P	Slight	do	Severe	50.00
1276	Suntara Nagpur	Lr	do			50.00
5173	Saagkam	Cn	None	None		0
3383	Madurensis	Lr	Slight	Slight		50.00
1262	Suntara	P	None	None		0
2984	Chinese	P&M	do	do		0
5142	Laurel	P	Slight	do		35.00
3883	Oneco	Cw	None	do		0
4828	Narangita	P	Slight	do	Slight	33.33
5138	Malvar	Cn	do	do	do	33.33
3139	Ubay	Cn	do	do	do	33.33
	Citrus sinensis					
1743	Mediterranean	Cw	None	Slight	Slight	33.33
1277	Seville	O	Slight	do	do	50.00
1742	Navelencia	M	None	None	None	0
1260	Excelsior	Lr&O	Severe	Slight	do	50.00
2685	Everbearing	Cw	Slight	None	do	16.66
2365	Orange	K	do	Slight	do	33.33
1270	St. Michael	O	None	do	do	16.66
1728	Cuyo	O	Slight	do	do	33.33
56	Jappa	O	do	do	Slight	50.00
1714	Larrantha	O	None	do	do	33.33
1715	White Siletta	O	Slight	do	do	50.00
1719	Jaffa	O	do	do	do	50.00
1720	Bahia	O	do	do	do	50.00
1705	Mediterranean	Lr&O	do	Severe	do	66.66
1706	Valencia	O	None	Slight	None	16.66
1711	Washington Navel	O	Slight	do	do	33.33
1639	Ruby	O	do	do	do	33.33
1635	Pineapple	O	do	do	do	33.33
1637	Jaffa	O	do	do	Slight	50.00
966	Cajel	O	None	do	do	33.33
51	Valencia	Cn	Severe	do	do	66.66
51	Do	O	Slight	do	do	50.00
2568	Misamis	Lr	Severe	do	Severe	83.33

[1] O=Sweet orange; P=Pummelo; Cn=Calamondin; SO=Sour orange; Lr=Lemon real; Le=Lime; Cw=*Citrus webberri;* M=Mandarin; K=Kabuyao; Csp=*Citrus sp.;* and Cmac =Citrus macrophylla.

TABLE I.—*Showing the citrus varieties resistant to the diseases*—Continued

P. I. No.	Variety name	Kind of stock [1]	Bark rot: Extent of infection 1922	1923	1924	Average per cent of infection
	Citrus sinensis—Continued					
2569	Valencia	Cn	None	None	None	0
2686	Pineapple	Cn	Slight	Slight	Died	50.00
2694	Majorca	Lr	None	do	None	16.66
2697	Maltese Blood	P	Slight	do	do	33.33
2695	Brown	Lr	Severe	do	Slight	66.66
2689	Enterprise		Slight	None	None	16.66
3886	Du Roi	SO	None	do	Died	0
3660	Balanga	Cn	Slight	Slight	None	33.33
4117	Brown	O	do	None	Slight	33.33
5119	Dugat	Le&Cw	do	Slight	do	50.00
4120	Du Roi	Le	do	Died		50.00
4123	Magnum bonum	O	do	Slight	None	33.33
5177	Pongkan	Cn	None	do	Slight	33.33
1259	Maltese Blood	Lr	Slight			50.00
2698	Boone	Cn	None	None	None	0
1258	Jaffa	O	do	do	Slight	16.66
4126	Foster	O	Slight	Slight	Severe	66.66
1266	Whitaker	P&Cn	None	None	Slight	16.66
5188	Orange	P	do	Slight	do	33.33
5522	Do	P	do	None	None	0
1701	Holdfast	O	do	Slight	Slight	33.33
4124	Carleton	O	Slight	None	None	16.66
1636	Washington Navel	O	Severe	Severe	Slight	83.33
	Citrus southwickii					
2049	C. southwickii	Le	do	do	Died	100.00
	Citrus sp.					
1273	Natsu dai-dai	O	None	Slight	None	16.66
3671	C. sp	Cn	do	None	Slight	16.66
	Citrus webberri					
2266	Cabugao Igorot	O	Severe	do	do	50.00
896	Alsem	O	Slight	do	None	16.66
853	Do	Lr	Severe	Severe	Severe	100.00
4828	C. webberri	P	None	None	None	0
5102	Lias	P&Cn	do	do	Slight	16.66
5105	Alsem	P	Slight	Slight	Died	50.00
5540	Lurad	P	do	do	do	50.00
5497	Ganid	P	None	do	do	25.00
5174	C. webberri	P	do	None	None	0

P. I. No.	Variety name	Kind of stock [1]	Canker: Extent of infection 1922	1923	1924	Average per cent of infection
	Citrus aurantifolia					
2182	Lime	O	Severe	Slight	Severe	83.33
1749	Mindoro lime	O	Slight	do	Slight	50.00
901	Dayap	O	Severe	Severe	Severe	100.00
902	Do	O	do	do	do	100.00
3670	Trinidad	Cn	do	Slight	do	83.33
5163	Tahiti	O	None	None	None	0
5176	Lime	P&Cn	Severe	Severe	Slight	83.33
4827	Lombog	P	Slight	Slight	do	50.00
3669	Everglade	Cn	Severe	Severe	do	83.33
5184	Kusaie	P	Slight	Slight	do	50.00

[1] O=Sweet orange; P=Pummelo; Cn=Calamondin; SO=Sour orange; Lr=Lemon real; Le=Lime; Cw=*Citrus webberri;* M=Mandarin; K=Kabuyao; Csp=*Citrus sp.;* and Cmac =Citrus macrophylla.

TABLE I.—*Showing the citrus varieties resistant to the diseases*—Continued

P. I. No.	Variety name	Kind of stock [1]	Canker: Extent of infection 1922	1923	1924	Average per cent of infection
	Citrus aurantium					
1264	Florida orange	P&M	Slight	Slight	Slight	50.00
1638	Sour orange	O	do	do	do	50.00
2511	Florida orange	O	do	do	do	50.00
2662	Sour orange	P	do	None	do	33.33
2385	Do		do	Slight	None	33.33
	Citrus excelsa					
833	Lemon real	P				
835	Chinese lemon	O				
1009	Lemon real	Stock	Severe	Slight	Slight	66.66
3388	Le Nestour	Lr	Slight	do		50.00
3665	Lemon real	Lr	Severe	do		75.00
3841	Tanchan	P	Slight	do	Slight	50.00
	Citrus hybrid					
1948	Sampson		None	None	None	0
1618	Do	O	Severe	Slight	Slight	66.66
1385	Do	P	do	do	do	66.66
	Citrus hystrix					
2535	Colo-colo	Cn	do	do	do	66.66
3668	C. hystrix	Cn	None	None	None	0
3656	Canci	Lr	Severe	Slight	Slight	66.66
3665	Colobot	P	do	do	do	66.66
2494	Cabuyao	O	Slight	do	do	50.00
5165	Suangui	A	Severe	do	do	66.66
4214	Camugao	Lr	Slight	do	do	50.00
4225	Calooy	Lr	do	do	do	50.00
4824	Canci	P	do	do	do	50.00
4830	Amontay	P	do	do	do	50.00
5137	Colobot	P	do	do	do	50.00
5189	Cabuyao	P	None	None	None	0
6539	Duroga		Slight	Slight	Severe	66.66
	Citrus limonia					
708	Lisbon	P	Severe	do	Slight	66.66
1712	Thornless	O	Died			
1704	Bengal	O	do			
4804	C. limonia	P	Slight	Slight	Died	50.00
5175	Do	K	Severe	do	Slight	66.66
	Rough lemon		Slight	do	do	50.00
	Citrus longispina					
3658	Camisan	Lr	Severe	do	do	66.66
4839	Tamisan	P	Slight	do	do	50.00
4840	Do	P	None	do	do	33.33
	Citrus macrophylla					
4820	Alemow	P	Slight	do	do	50.00
	Citrus maxima					
2265	Lukban	O	do	do	do	50.00
1713	Triumph	O	do	do	do	50.00
1707	Marsh	O	Severe	Severe	Severe	100.00
1633	Case	O	Slight	Slight	Slight	50.00
1631	Marsh	O	Severe	do	do	66.66
1632	Triumph	O	Slight	do	do	50.00
1334	Pernambuco	O&Csp	Severe	Severe	Severe	100.00
1333	Ellen	O	do	Slight	Slight	66.66
891	Pomelo	O	Slight	do	do	50.00
893	Do	O	Severe	do	do	66.66
899	Do	O	do	do	do	66.66
5181	Do	P	Slight	do	do	50.00
2700	McCarthy	P	do	do	Severe	66.66
1995	Siamese	P	do	do	Slight	50.00
2687	Duncan	P	Severe	do	do	66.66

[1] O=Sweet orange; P=Pummelo; Cn=Calamondin; SO=Sour orange; Lr=Lemon real; Le=Lime; Cw=*Citrus webberri;* M=Mandarin; K=Kabuyao; Csp=*Citrus sp.;* and Cmac =Citrus macrophylla.

TABLE I.—*Showing the citrus varieties resistant to the diseases*—Continued

P. I. No.	Variety name	Kind of stock[1]	Canker: Extent of infection 1922	1923	1924	Average per cent of infection
	Citrus marima—Continued					
2690	Marsh		Severe	Slight	Slight	66.66
3882	McCarthy	SO	Slight	do	do	50.00
	Jolo pomelo		Severe	do	do	66.66
3389	Siamese	P	Slight	do	do	50.00
4118	Walter	SO&O	Severe	do	do	66.66
4121	McCarthy	Cw	do	Severe	Severe	100.00
4125	Royal	Cmac	Slight	Slight	Slight	50.00
2524	Pomelo	P	do	do	do	50.00
3673	Siamese	O	Severe	do	do	66.66
5152	Do	P	do	do	do	66.66
3392	Do	P	Slight	do	do	50.00
3391	Do	P	do	do	do	50.00
2503	Boongone	O	None	None	None	0
3442	Siamese	SO	Slight	Slight	Slight	50.00
3876	Nakoin	P	Severe	do	do	66.66
5103	Panuban	P	Slight	do	do	50.00
4868	Kellogg	P	Severe	do	do	66.66
5144	Panuban	P	do	do	do	66.66
5146	Do	P	Slight	do	do	50.00
5528	Pomelo	P	do	do	do	50.00
3384	Saigon	P	do	do	do	50.00
	Citrus medica					
2183	Citron	O	Slight	Slight	Slight	50.00
1716	Do	O	do	do	do	50.00
848	Merrill	O	Severe	do	do	66.66
4739	Pesak	SO	Slight	do		50.00
4826	Cidra	Cn	do	do		50.00
2264	Tambuyog	K	Severe	do	Slight	66.66
	Citrus miary					
6589	C. miary		Slight	do	do	50.00
	Citrus micrantha					
2502	Biasong	O	do	do	do	50.00
4821	Samuyao	P	do			50.00
	Citrus mitis					
1718	C. mitis	O	None	None		0
2355	Calamondin	P	do	do	None	0
2513	Do	Lr	do	do	do	0
2332	Do	Le	do	do	do	0
2534	Do	Cn	do	do	do	0
	Citrus nobilis					
1265	China	Cw	do	do	do	0
1271	Kishiu	O	do	do	do	0
1272	Konda Narum	O&Cn	do	do	do	0
1918	Dancy		do	do	do	0
1335	Oneco	O&Cn	do	do	do	0
1256	Ladu	Lr	do	Slight	do	16.66
744	Tizon	O	do	None	do	0
745	Do	Lr	Slight	do	do	16.66
2693	King	P	None	do	do	0
1276	Suntara Nagpur	Lr	do			0
5173	Saagkam	Cn	do	Slight		25.00
3383	Madurensis	Lr	Slight	do		50.00
1262	Suntara	P	None	None		0
2984	Chinese	P&M	do	do		0
5142	Laurel	P	do	do		0
3883	Oneco	Cw	do	do		0
4828	Narangita	P	do	do	None	0
5138	Malvar	Cn	do	Slight	Slight	33.33
3139	Ubay	Cn	do	None	None	0

[1] O=Sweet orange; P=Pummelo; Cn=Calamondin; SO=Sour orange; Lr=Lemon real; Le=Lime; Cw=*Citrus webberri;* M=Mandarin; K=Kabuyao; Csp=*Citrus sp.;* and Cmac =Citrus macrophylla.

TABLE I.—*Showing the citrus varieties resistant to the diseases*—Continued

P. I. No.	Variety name	Kind of stock [1]	Canker: Extent of infection 1922	1923	1924	Average per cent of infection
	Citrus sinensis					
1743	Mediterranean	Cw	Slight	Slight	Slight	50.00
1277	Seville	O	do	do	do	50.00
1742	Navelencia	M	do	do	do	50.00
1260	Excelsior	Lr&O	do	do	do	50.00
2685	Everbearing	Cw	do	do	do	50.00
2365	Orange	K	do	do	do	50.00
1270	St. Michel	O	do	do	do	50.00
1728	Cuyo	O	Severe	do	do	66.66
56	Jappa	O	Slight	do	do	50.00
1714	Larrantha	O	Severe	do	do	66.66
1715	White Siletta	O	do	do	do	66.66
1719	Jaffa	O	Slight	do	do	50.00
1720	Bahia	O	do	do	do	50.00
1705	Mediterranean	Lr&O	do	do	do	50.00
1706	Valencia	O	Severe	do	do	66.66
1711	Washington Navel	O	Slight	do	do	50.00
1639	Ruby	O	do	do	do	50.00
1635	Pineapple	O	do	do	do	50.00
1637	Jaffa	O	do	do	do	50.00
966	Cajel	O	Severe	do	do	66.66
51	Valencia	Cn	Slight	do	do	50.00
51	Do	O	do	do	do	50.00
2568	Misamis	Lr	Severe	do	do	66.66
2569	Valencia	Cn	Slight	do	do	50.00
2686	Pineapple	Cn	do	do		50.00
2694	Majorca	Lr	do	do	Slight	50.00
2697	Maltese Blood	P	do	do	do	50.00
2695	Brown	Lr	do	do	do	50.00
2689	Enterprise		do	do	do	50.00
3886	Du Roi	SO	do	do		50.00
3660	Balanga	Cn	Severe	do	Slight	66.66
4117	Brown	O	do	do	do	66.66
5119	Dugat	Le&Cw	Slight	do	do	50.00
4120	Du Roi	Le	do			50.00
4123	Magnum bonum	O	Severe	Slight	Slight	66.66
5177	Pongkan	Cn	Slight	do	do	50.00
1259	Maltese Blood	Lr	do			50.00
2698	Boone	Cn	do	Slight	Slight	50.00
1258	Jaffa	O	do	do	do	50.00
4126	Foster	O	do	do	do	50.00
1266	Whitaker	P&Cn	do	do	do	50.00
5188	Orange	P	None	None	None	0
5522	Do	P	do	do	do	0
1701	Holdfast	O	Slight	Slight	Slight	50.00
4124	Carleton	O	Severe	do	do	66.66
1636	Washington Navel	O	Slight	do	do	50.00
	Citrus southwickii					
2049	C. southwickii	Le	do	do		50.00
	Citrus sp.					
1273	Natsu dai-dai	O	Slight	Slight	Slight	50.00
3671	C. sp.	Cn	do	do	do	50.00
	Citrus webberri					
2266	Cabugao Igorot	O	do	do	None	33.33
896	Alsem	O	do	do	Slight	50.00
853	Do	Lr	do	do	None	33.33
4828	C. webberri	P	None	do	Slight	33.33
5102	Lias	P&Cn	do	None	None	0
5105	Alsem	P	do	do		0
5540	Lurad	P	do	Slight		16.66
5497	Ganid	P	do	None		0
5174	C. webberri	P	Severe	Slight	Slight	66.66

[1] O=Sweet orange; P=Pummelo; Cn=Calamondin; SO=Sour orange; Lr=Lemon real; Le=Lime; Cw=*Citrus webberri;* M=Mandarin; K=Kabuyao; Csp=*Citrus sp.;* and Cmac =Citrus macrophylla.

TABLE I.—*Showing the citrus varieties resistant to the diseases*—Continued

P. I. No.	Variety name	Kind of stock[1]	Foot rot: Extent of infection 1922	1923	1924	Average per cent of infection
	Citrus aurantifolia					
2182	Lime	O	None	None	None	0
1749	Mindoro lime	O	do	do	do	0
901	Dayap	O	do	do	do	0
902	Do	O	do	do	do	0
3670	Trinidad	Cn	do	do	do	0
5168	Tahiti	O	do	do	do	0
5176	Lime	P&Cn	do	do	Slight	16.66
4827	Lombog	P	do	do	None	0
3669	Everglade	Cn	do	do	do	0
5184	Kusaie	P	do	do	do	0
	Citrus aurantium					
1264	Florida orange	P&M	do	do	do	0
1638	Sour orange	O	do	do	do	0
2511	Florida orange	O	do	do	do	0
2662	Sour orange	P	Slight	do	do	16.66
?385	Do		None	do	do	0
	Citrus excelsa					
833	Lemon real	P				
835	Chinese lemon	O				
1009	Lemon real	Stock	None	None	None	0
3388	Le Nestour	Lr	do	do		0
3665	Lemon real	Lr	do	do		0
3841	Tanchan	P	do	do	None	0
	Citrus hybrid					
1948	Sampson		do	do	do	0
1618	Do	O	do	Slight	do	16.66
1385	Do	P	do	None	do	0
	Citrus hystrix					
2535	Colo-colo	Cn	do	do	do	0
3668	C. hystrix	Cn	do	do	do	0
3656	Canci	Lr	do	do	do	0
3665	Colobot	P	do	do	do	0
2494	Cabuyao	O	do	do	do	0
5165	Suangui	A	do	do	do	0
4214	Camugao	Lr	do	do	Slight	16.66
4225	Calooy	Lr	do	do	None	0
4824	Canci	P	do	do	do	0
4830	Amontay	P	do	do	do	0
5137	Colobot	P	do	do	do	0
5189	Cabuyao	P	do	do	do	0
6539	Duroga		do	do	do	0
	Citrus limonia					
708	Lisbon	P	do	do	do	0
1712	Thornless	O	Died			
1704	Bengal	O	do			
4804	C. limonia	P	None	None	Died	0
5175	Do	K	do	do	None	0
	Rough lemon		do	do	do	0
	Citrus longispina					
3658	Camisan	Lr	do	do	do	0
4839	Tamisan	P	do	do	do	0
4840	Do	P	do	do	do	0
	Citrus macrophylla					
4820	Alemow	P	do	do	do	0

[1] O=Sweet orange; P=Pummelo; Cn=Calamondin; SO=Sour orange; Lr=Lemon real; Le=Lime; Cw=*Citrus webberri;* M=Mandarin; K=Kabuyao; Csp=*Citrus sp.;* and Cmac =Citrus macrophylla.

TABLE I.—*Showing the citrus varieties resistant to the diseases*—Continued

P. I. No.	Variety name	Kind of stock [1]	Foot rot: Extent of infection 1922	1923	1924	Average per cent of infection
	Citrus maxima					
2265	Lukban	O	None	None	None	0
1718	Triumph	O	do	do	do	0
1707	Marsh	O	do	do	do	0
1633	Case	O	do	do	do	0
1631	Marsh	O	do	do	do	0
1632	Triumph	O	do	do	do	0
1334	Pernambuco	O&Csp	do	do	do	0
1338	Ellen	O	do	do	do	0
891	Pomelo	O	do	do	do	0
893	Do	O	do	do	do	0
899	Do	O	do	do	do	0
5181	Do	P	do	do	do	0
2700	McCarthy	P	do	do	do	0
1995	Siamese	P	do	do	do	0
2687	Duncan	P	do	do	do	0
2690	Marsh		do	do	do	0
3882	McCarthy	SO	do	do	do	0
	Jolo pomelo		do	do	do	0
3389	Siamese	P	do	do	do	0
4118	Walter	SO&O	do	do	Slight	16.66
4121	McCarthy	Cw	do	do	None	0
4125	Royal	Cmac	do	do	Slight	16.66
2524	Pomelo	P	do	do	None	0
3673	Siamese	O	do	do	do	0
5152	Do	P	do	do	do	0
3392	Do	P	do	do	do	0
3391	Do	P	do	do	do	0
2503	Boongone	O	do	do	do	0
3442	Siamese	SO	do	do	do	0
3876	Nakoin	P	do	do	do	0
5103	Panuban	P	do	do	do	0
4868	Kellogg	P	do	do	do	0
5144	Panuban	P	do	do	do	0
5146	Do	P	do	do	do	0
5523	Pomelo	P	do	do	do	0
3384	Saigon	P	do	do	do	0
	Citrus medica					
2183	Citron	O	do	do	do	0
1716	Do	O	do	do	do	0
848	Murrill	O	do	do	do	0
4739	Pesak	SO	do	do		0
4826	Cidra	Cn	do	do		0
2264	Tambuyog	K	do	do	None	0
	Citrus miary					
6589	C. miary		do	do	do	0
	Citrus micrantha					
2502	Biasong	O	do	do	do	0
4821	Samuyao	P	do			0
	Citrus mitis					
1718	C. mitis	O	do	do		0
2355	Calamondin	P	do	do	None	0
2513	Do	Lr	do	do	do	0
2332	Do	Lr	do	do	do	0
2534	Do	Cn	do	do	do	0
	Citrus nobilis					
1265	China	Cw	do	do	do	0
1271	Kishiu	O	do	do	do	0
1272	Konda Narum	O&Cn	do	do	do	0
1918	Dancy		do	do	do	0

[1] O=Sweet orange; P=Pummelo; Cn=Calamondin; SO=Sour orange; Lr=Lemon real; Le=Lime; Cw=*Citrus webberi;* M=Mandarin; K=Kabuyao; Csp=*Citrus sp.;* and Cmac =Citrus macrophylla.

TABLE I.—*Showing the citrus varieties resistant to the diseases*—Continued

P. I. No.	Variety name	Kind of stock [1]	Foot rot: Extent of infection 1922	1923	1924	Average per cent of infection
	Citrus nobilis—Continued					
1335	Oneco	O&Cn	None	None	None	0
1256	Ladu	Lr	do	do	do	0
744	Tizon	O	do	do	do	0
745	Do	Lr	do	do	do	0
2698	King	P	do	do	do	0
1276	Suntara Nagpur	Lr	do			0
5178	Saagkam	Cn	do	None		0
3383	Madurensis	Lr	do	do		0
1262	Suntara	P	do	do		0
2984	Chinese	P&M	do	do		0
5142	Laurel	P	do	do		0
3883	Oneco	Cw	do	do		0
4828	Narangita	P	do	do	None	0
5138	Malvar	Cn	do	do	do	0
3139	Ubay	Cn	do	do	do	0
	Citrus sinensis					
1743	Mediterranean	Cw	do	do	do	0
1277	Seville	O	do	do	do	0
1742	Navelencia	M	do	do	do	0
1260	Excelsior	Lr&O	do	do	do	0
2685	Everbearing	Cw	do	do	do	0
2365	Orange	K	do	do	do	0
1270	St. Michael	O	do	do	do	0
1728	Cuyo	O	do	do	do	0
56	Jaffa	O	do	do	do	0
1714	Larrantha	O	Severe	do	Slight	50.00
1715	White Siletta	O	None	do	None	0
1719	Jaffa	O	do	do	do	0
1720	Bahia	O	do	do	do	0
1705	Mediterranean	Lr&O	do	do	do	0
1706	Valencia	O	do	do	do	0
1711	Washington Navel	O	do	do	do	0
1639	Ruby	O	do	do	do	0
1635	Pineapple	O	do	do	do	0
1637	Jaffa	O	do	do	do	0
966	Cajel	O	do	do	do	0
51	Valencia	Cn	do	do	do	0
51	Do	O	do	do	do	0
2568	Misamis	Lr	do	do	Slight	16.66
2569	Valencia	Cn	do	do	None	0
2686	Pineapple	Cn	do	do		0
2694	Majorca	Lr	do	do	None	0
2697	Maltese Blood	P	do	do	do	0
2695	Brown	Lr	Slight	do	do	16.66
2689	Enterprise		None	do	do	0
3886	Du Roi	SO	do	do		0
3660	Balanga	Cn	do	do	None	0
4117	Brown	O	do	do	do	0
5119	Dugat	Le&Cw	do	do	do	0
4120	Du Roi	Le	do			0
4123	Magnum bonum	O	do	None	None	0
5177	Pongkan	Cn	do	do	do	0
1259	Maltese Blood	Lr	do	do	do	0
2698	Boone	Cn	do	do	do	0
1258	Jaffa	O	do	do	do	0
4126	Foster	O	do	do	do	0
1266	Whitaker	P&Cn	do	do	do	0
5188	Orange	P	do	do	do	0
5522	Do	P	do	do	do	0
1701	Holdfast	O	do	do	do	0
4124	Carleton	O	do	do	do	0
1636	Washington Navel	O	do	do	do	0

[1] O=Sweet orange; P=Pummelo; Cn=Calamondin; SO=Sour orange; Lr=Lemon real; Le=Lime; Cw=*Citrus webberri;* M=Mandarin; K=Kabuyao; Csp=*Citrus sp.;* and Cmac =Citrus macrophylla.

TABLE I.—*Showing the citrus varieties resistant to the diseases*—Continued

P. I. No.	Variety name	Kind of stock [1]	Foot rot — Extent of infection 1922	1923	1924	Average per cent of infection
	Citrus southwickii					
2049	C. southwickii	Le	None	None	None	0
	Citrus sp.					
1273	Natsu dai-dai	O	do	do	do	0
3671	C. sp.	Cn	do	do	do	0
	Citrus webberri					
2266	Cabugao Igorot	O	Slight	do	do	16.66
896	Alsem	O	None	do	do	0
853	Do	Lr	Slight	do	do	16.66
4828	C. webberri	P	None	do	do	0
5102	Lias	P&Cn	do	do	do	0
5105	Alsem	P	do	do	do	0
5540	Lured	P	do	do		0
5497	Ganid	P	do	do		0
5174	C. webberri	P	do	do	None	0

P. I. No.	Variety name	Kind of stock [1]	Mottled leaf — Extent of infection 1922	1923	1924	Average per cent of infection
	Citrus aurantifolia					
2182	Lime	O	None	None	None	0
1749	Mindoro lime	O	do	do	do	0
901	Dayap	O	do	do	do	0
902	Do	O	do	do	do	0
3670	Trinidad	Cn	do	do	do	0
5163	Tahiti	O	do	do	do	0
5176	Lime	P&Cn	do	do	do	0
4827	Lombog	P	do	do	do	0
3669	Everglade	Cn	do	do	do	0
5184	Kusaie	P	do	do	do	0
	Citrus aurantium					
1264	Florida orange	P&M	Slight	Slight	Slight	50.00
1638	Sour orange	O	do	Severe	do	66.66
2511	Florida orange	O	do	Slight	do	50.00
2662	Sour orange	P	do	Severe	Severe	83.33
2385	Do		do	Slight	Slight	50.00
	Citrus excelsa					
833	Lemon real	P				
835	Chinese lemon	O				
1009	Lemon real	Stock	None	None	None	0
3388	Le Nestour	Lr	do	do	do	0
3665	Lemon real	Lr	do	do	do	0
3841	Tanchan	P	do	do	do	0
	Citrus hybrid					
1948	Sampson		Severe	Severe	Slight	83.33
1618	Do	O	Slight	do	do	66.66
1385	Do	P	Severe	Slight	do	66.66

[1] O=Sweet orange; P=Pummelo; Cn=Calamondin; SO=Sour orange; Lr=Lemon real; Le=Lime; Cw=*Citrus webberri;* M=Mandarin; K=Kabuyao; Csp=*Citrus sp.;* and Cmac =Citrus macrophylla.

TABLE I.—*Showing the citrus varieties resistant to the diseases*—Continued

P. I. No.	Variety name	Kind of stock [1]	Mottled leaf — Extent of infection 1922	1923	1924	Average per cent of infection
	Citrus hystrix					
2535	Colo-colo	Cn	None	None	None	0
3668	C. hystrix	Cn	Slight	Slight	do	33.33
3656	Canci	Lr	None	None	Slight	16.66
3665	Colobot	P	do	do	None	0
2494	Cabuyao	O	do	do	Slight	16.66
5165	Suangui	A	do	do	None	0
4214	Camugao	Lr	do	do	do	0
4225	Calooy	Lr	do	do	do	0
4824	Canci	P	Severe	Slight	Slight	66.66
4830	Amontay	P	None	None	None	0
5137	Colobot	P	Slight	do	do	16.66
5189	Cabuyao	P	None	do	Slight	16.66
6539	Duroga		do	do	None	0
	Citrus limonia					
708	Lisbon	P	do	do	do	0
1712	Thornless	O				
1704	Bengal	O				
4804	C. limonia	P	Severe	Severe		100.00
5175	Do	K	None	None	None	0
	Rough lemon		do	do	do	0
	Citrus longispina					
3658	Camisan	Lr	do	Slight	Slight	33.33
4839	Tamisan	P	do	None	None	0
4840	Do	P	do	Slight	Slight	33.33
	Citrus macrophylla					
4820	Alemow	P	Slight	do	do	50.00
	Citrus maxima					
2265	Lukban	O	do	do	do	50.00
1713	Triumph	O	Severe	Severe	do	83.33
1707	Marsh	O	Slight	Slight	do	50.00
1633	Case	O	do	do	do	50.00
1631	Marsh	O	do	Severe	do	66.66
1632	Triumph	O	do	Slight	do	50.00
1334	Pernambuco	O&Csp	do	do	do	50.00
1333	Ellen	O	do	Severe	do	66.66
891	Pomelo	O	do	Slight	do	50.00
893	Do	O	None	do	do	33.33
899	Do	O	Slight	do	do	50.00
5181	Do	P	do	None	None	16.66
2700	McCarthy	P	do	Severe	Slight	66.66
1995	Siamese	P	do	Slight	do	50.00
2687	Duncan	P	do	Severe	do	66.66
2690	Marsh		Severe	do	do	83.33
3882	McCarthy	SO	Slight	Slight	do	50.00
	Jolo pomelo		None	do	do	33.33
3389	Siamese	P	do	do	None	16.66
4118	Walter	SO&O	Slight	Severe	Slight	66.66
4121	McCarthy	Cw	do	Slight	do	50.00
4125	Royal	Cmac	Severe	Severe	do	83.33
2524	Pomelo	P	Slight	Slight	do	50.00
3673	Siamese	O	None	do	do	33.33
5152	Do	P	Slight	do	do	50.00
3392	Do	P	do	do	do	50.00
3391	Do	P	None	None	do	16.66
2503	Boongone	O	do	Slight	None	16.66
3442	Siamese	SO	do	do	do	16.66
3876	Nakoin	P	Severe	do	Slight	66.66

[1] O=Sweet orange; P=Pummelo; Cn=Calamondin; SO=Sour orange; Lr=Lemon real; Lc=Lime; Cw=*Citrus webberri;* M=Mandarin; K=Kabuyao; Csp=*Citrus sp.;* and Cmac =Citrus macrophylla.

TABLE I.—*Showing the citrus varieties resistant to the diseases*—Continued

P. I. No.	Variety name	Kind of stock [1]	Mottled leaf — Extent of infection 1922	1923	1924	Average per cent of infection
	Citrus maxima—Continued					
5103	Panuban	P	Severe	Slight	Slight	66.66
4868	Kellogg	P	Slight	do	do	50.00
5144	Panuban	P	do	do	do	50.00
5146	Do	P	do	do	do	50.00
5523	Pomelo	P	None	do	do	33.33
3384	Saigon	P	Severe	do	do	66.66
	Citrus medica					
2183	Citron	O	None	None	None	0
1716	Do	O	do	do	do	0
848	Murrill	O	do	do	do	0
4739	Pesak	SO	do	do		0
4826	Cidra	Cn	do	do		0
2264	Tambuyog	K	do	do	None	0
	Citrus miary					
6589	C. miary		do	Slight	do	16.66
	Citrus micrantha					
2502	Biasong	O	do	None	do	0
4821	Samuyao	P	Severe			100.00
	Citrus mitis					
1718	C. mitis	O	do	Slight		75.00
2355	Calamondin	P	None	None	None	0
2513	Do	Lr	do	do	do	0
2332	Do	Lr	do	do	do	0
2534	Do	Cn	do	do	do	0
	Citrus nobilis					
1265	China	Cw	do	do	do	0
1271	Kishiu	O	Slight	Slight	Slight	50.00
1272	Konda Narum	O&Cn	None	do	do	33.33
1918	Dancy		do	Severe	Severe	66.66
1335	Oneco	O&Cn	Slight	Slight	Slight	50.00
1256	Ladu	Lr	None	do	None	16.66
744	Tizon	O	Slight	Severe	Slight	66.66
745	Do	Lr	do	Slight	do	50.00
2693	King	P	do	Severe	do	66.66
1276	Suntara Nagpur	Lr	do			50.00
5173	Saagkam	Cn	None	None		0
3383	Madurensis	Lr	Slight	Slight		50.00
1262	Suntara	P	do	do		50.00
2984	Chinese	P&M	do	None		25.00
5142	Laurel	P	do	Slight		50.00
3888	Oneco	Cw	None	do		25.00
4828	Narangita	P	Slight	do	Slight	50.00
5138	Malvar	Cn	None	None	None	0
3139	Ubay	Cn	do	do	do	0
	Citrus sinensis					
1743	Mediterranean	Cw	Slight	Slight	Slight	50.00
1277	Seville	O	do	do	do	50.00
1742	Navelencia	M	None	None	None	0
1260	Excelsior	Lr&O	Slight	Slight	Slight	50.00
2685	Everbearing	Cw	do	do	do	50.00
2365	Orange	K	do	do	do	50.00
1270	St. Michael	O	do	do	do	50.00
1728	Cuyo	O	do	do	do	50.00

[1] O=Sweet orange; P=Pummelo; Cn=Calamondin; SO=Sour orange; Lr=Lemon real; Lc=Lime; Cw=*Citrus webberri;* M=Mandarin; K=Kabuyao; Csp=*Citrus sp.;* and Cmac =Citrus macrophylla.

TABLE I.—*Showing the citrus varieties resistant to the diseases*—Continued

P. I. No.	Variety name	Kind of stock [1]	Mottled leaf — Extent of infection 1922	1923	1924	Average per cent of infection
	Citrus sinensis—Continued					
56	Jappa	O	Slight	Slight	Slight	50.00
1714	Larrantha	O	do	Severe	do	66.66
1715	White Siletta	O	do	do	do	66.66
1719	Jaffa	O	do	Slight	do	50.00
1720	Bahia	O	do	do	do	50.00
1705	Mediterranean	Lr&O	do	Severe	do	66.66
1706	Valencia	O	do	Slight	do	50.00
1711	Washington Navel	O	None	do	None	16.66
1639	Ruby	O	Slight	do	Slight	50.00
1635	Pineapple	O	do	Severe	do	66.66
1637	Jaffa	O	do	Slight	do	50.00
966	Cajel	O	do	do	do	50.00
51	Valencia	Cn	None	do	do	33.33
51	Do	O	Slight	do	do	50.00
2568	Misamis	Lr	do	do	do	50.00
2569	Valencia	Cn	do	do	do	50.00
2686	Pineapple	Cn	do	do		50.00
2694	Majorca	Lr	do	do	Slight	50.00
2697	Maltese Blood	P	do	do	do	50.00
2695	Brown	Lr	do	do	do	50.00
2689	Enterprise		do	Severe	do	66.66
3886	Du Roi	SO	do	None		25.00
3660	Balanga	Cn	do	Slight	Slight	50.00
4117	Brown	O	do	do	do	50.00
5119	Dugat	Le&Cw	do	do	do	50.00
4120	Du Roi	Le	do			50.00
4123	Magnum bonum	O	do	Slight	Slight	50.00
5177	Pongkan	Cn	do	None	do	33.33
1259	Maltese Blood	Lr	do			50.00
2698	Boone	Cn	do	Slight	Slight	50.00
1258	Jaffa	O	do	do	do	50.00
4126	Foster	O	do	do	do	50.00
1266	Whitaker	P&Cn	None	do	do	33.33
5188	Orange	P	Severe	Severe	do	83.33
5522	Do	P	Slight	Slight	None	33.33
1701	Holdfast	O	do	Severe	Slight	66.66
4124	Carleton	O	do	Slight	do	50.00
1636	Washington Navel	O	do	do	do	50.00
	Citrus southwickii					
2049	C. southwickii	Le	None	None		0
	Citrus sp.					
1273	Natsu dai-dai	O	Slight	Slight	Slight	50.00
3671	C. sp.	Cn	do	do	do	50.00
	Citrus webberri					
2266	Cabugao Igorot	O	None	do	do	33.33
896	Alsem	O	Slight	do	do	50.00
853	Do	Lr	None	do	do	33.33
4828	C. webberri	P	do	do	do	33.33
5102	Lias	P&Cn	Severe	do	do	66.66
5105	Alsem	P	Slight	do		50.00
5540	Lurad	P	None	do		16.66
5497	Ganid	P	Severe	Severe		100.00
5174	C. webberri	P	None	None	None	0

[1] O=Sweet orange; P=Pummelo; Cn=Calamondin; SO=Sour orange; Lr=Lemon real; Le=Lime; Cw=*Citrus webberri;* M=Mandarin; K=Kabuyao; Csp=*Citrus sp.;* and Cmac =Citrus macrophylla.

TABLE II.—*Showing the disease resistant citrus species*

Species	Number of varieties under observation			Number of trees under observation			Pink disease: Number of trees severely attacked			Pink disease: Number of trees slightly attacked			Pink disease: Number of trees not attacked			Pink disease: Number of trees that died		
	1922	1923	1924	1922	1923	1924	1922	1923	1924	1922	1923	1924	1922	1923	1924	1922	1923	1924
C. aurantifolia	9	8	8	17	15	15	1	1	1			2	16	14	12			
C. aurantium	6	6	6	12	12	12							12	12	12			
C. excelsa	6	4	4	6	4	4							6	4	4			
C. hybrid	3	3	3	6	6	5							6	6	5			
C. hystrix	13	13	12	18	18	17			1				19	18	16			
C. limonia	5	3	4	6	4	5							6	4	5			
C. longispina	3	3	3	4	4	5							4	4	5			
C. maxima	36	36	36	55	55	53	1						56	55	53			
C. medica	6	6	4	8	7	5							8	7	6			
C. miary	1	1	1	1	1	1							2	1	1			
C. micrantha	2	2	1	2	2	1							2	2	1			
C. mitis	5	5	5	8	8	8						1	8		7			
C. nobilis	18	17	17	35	35	30		1	1				37	34	29			
C. sinensis	45	45	45	73	73	70	3	2				5	73	70	65	1		
C. southwickii	1	1	1	2	2	2							2	2	2			
C. species	2	2	3	3	3	5							3	3	5			
C. webberri	10	10	10	15	14	14							15	14	14			
Total	171	165	163	271	263	252	5	4	3			8	275	250	242	1		

TABLE II.—*Showing the disease resistant citrus species*—Continued

Species	Number of varieties under observation			Number of trees under observation			Bark rot: Number of trees severely attacked			Bark rot: Number of trees slightly attacked			Bark rot: Number of trees not attacked			Bark rot: Number of trees that died		
	1922	1923	1924	1922	1923	1924	1922	1923	1924	1922	1923	1924	1922	1923	1924	1922	1923	1924
C. aurantifolia	9	8	8	17	15	15	7	7	3	4	6	8	5	2	3	1		1
C. aurantium	6	6	6	12	12	12	1			1	1	2	10	11	10			
C. excelsa	6	4	4	6	4	4	3	1	1		3	1	3			2		2
C. hybrid	3	3	3	6	6	5	1	2		2	2	4	3	2	1			1
C. hystrix	13	13	12	18	18	17	1	3	1	2	3	7	16	12	8			1
C. limonia	5	3	4	6	4	5	3			1	2	3	2	2	1	2		1
C. longispina	3	3	3	4	4	5	2		1			2	2	4	2			
C. maxima	36	36	36	55	55	53	7	2	3	18	23	25	32	30	22	2	1	3
C. medica	6	6	4	8	7	5	5	6	2	2		1	1	1		1	1	2
C. miary	1	1	1	1	1	1	1					1	1	1		1		
C. micrantha	2	2	1	2	2	1		1		2				1	1		1	
C. mitis	5	5	5	8	8	8	1	1	1	1		4	6	7	2			1
C. nobilis	18	17	17	35	35	30	1			8	8	17	28	27	12	1	2	1
C. sinensis	45	45	45	73	73	70	8	3	3	29	41	27	39	28	37	2	2	3
C. southwickii	1	1	1	2	2	2	1	1					1	1				2
C. species	2	2	3	3	3	5					1	3	3	2	2			
C. webberri	10	10	10	15	14	14	2	2	1	6	3	4	7	9	5	1		4
Total	171	165	163	271	263	252	44	29	16	76	93	109	159	140	106	13	7	22

Species	Number of varieties under observation			Number of trees under observation			Foot rot: Number of trees severely attacked			Foot rot: Number of trees slightly attacked			Foot rot: Number of trees not attacked			Foot rot: Number of trees that died		
	1922	1923	1924	1922	1923	1924	1922	1923	1924	1922	1923	1924	1922	1923	1924	1922	1923	1924
C. aurantifolia	9	8	8	17	15	15						1	17	15	14			
C. aurantium	6	6	6	12	12	12				1			11	12	12			
C. excelsa	6	4	4	6	4	4							6	4	4			
C. hybrid	3	3	3	6	6	5					1	2	6	5	5			

C. hystrix	13	13	12	18	18	17						1	19	18	16			
C. limonia	5	3	4	6	4	5							6	4	5			
C. longispina	3	3	3	4	4	5							4	4	5			
C. maxima	36	36	36	55	55	53							57	55	53			
C. medica	6	6	4	8	7	5	1						7	7	5			
C. miary	1	1	1	1	1	1							2	1	1			
C. micrantha	2	2	1	2	2	1							2	2	1			
C. mitis	5	5	5	8	8	8							8	8	8			
C. nobilis	18	17	17	35	35	30							37	35	30			
C. sinensis	45	45	45	73	73	70	1			2		2	73	73	68			
C. southwickii	1	1	1	2	2	2							2	2	2			
C. species	2	2	3	3	3	5							3	3	5			
C. webberri	10	10	10	15	14	14				2			13	14	14			
Total	171	165	163	271	263	252	2			5	1	6	273	262	248			

Canker

Species	Number of varieties under observation			Number of trees under observation			Number of trees severely attacked			Number of trees slightly attacked			Number of trees not attacked			Number of trees that died		
	1922	1923	1924	1922	1923	1924	1922	1923	1924	1922	1923	1924	1922	1923	1924	1922	1923	1924
C. aurantifolia	9	8	8	17	15	15	11	7	3	4	7	11	2	1	1			
C. aurantium	6	6	6	12	12	12	1	1		10	9	8	1	2	4			
C. excelsa	6	4	4	6	4	4	2	2		3	2	4	1					
C. hybrid	3	3	3	6	6	5	3	1	24	1	2	3	2	3	2			
C. hystrix	13	13	12	18	18	17	7	1	1	9	15	14	3	2	2			
C. limonia	5	3	4	6	4	5	3			1	4	5	2					
C. longispina	3	3	3	4	4	5	2			1	4	4	1		1			
C. maxima	36	36	36	55	55	53	34	21	4	21	32	47	2	2	2			
C. medica	6	6	4	8	7	5	4	2		3	5	5						
C. miary	1	1	1	1	1	1				1	1	1	1					
C. micrantha	2	2	1	2	2	1				2	2	1						
C. mitis	5	5	5	8	8	8							8	8	8			
C. nobilis	18	17	17	35	35	30				2	5	3	35	30	27			
C. sinensis	45	45	45	73	73	70	24	2		47	67	68	5	3	2			
C. southwickii	1	1	1	2	2	2				1	2	2	1					
C. species	2	2	3	3	3	5	1			2	3	5						
C. webberri	10	10	10	15	14	14	3			4	9	6	8	5	8			
Total	171	165	163	271	263	252	95	37	32	112	169	187	72	56	57			

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TABLE 11.—*Showing the disease resistant citrus species*—Continued

Species	Number of varieties under observation			Number of trees under observation			Mottled leaf											
							Number of trees severely attacked			Number of trees slightly attacked			Number of trees not attacked			Number of trees that died		
	1922	1923	1924	1922	1923	1924	1922	1923	1924	1922	1923	1924	1922	1923	1924	1922	1923	1924
. aurantifolia	9	8	8	17	15	15							17	15	15			
. aurantium	6	6	6	12	12	12	2	5	1	9	7	7	1		4			
. excelsa	6	4	4	6	4	4							6	4	4			
. hybrid	3	3	3	6	6	5	6	5	1		1	4						
. hystrix	13	13	12	18	18	17	1	2		3	1	4	15	15	13			
. limonia	5	3	4	6	4	5							6	4	5			
. longispina	3	3	3	4	4	5		1			2	4	4	1	1			
. maxima	36	36	36	55	55	53	15	20	4	29	31	45	13	4	4			
. medica	6	6	4	8	7	5							8	7	5			
. miary	1	1	1	1	1	1					1		2		1			
. micrantha	2	2	1	2	2	1	1				1		1	1	1			
. mitis	5	5	5	8	8	8	1	1				1	7	7	7			
. nobilis	18	17	17	35	35	30	6	6	2	8	14	12	23	15	16			
. sinensis	45	45	45	73	73	70	14	15	2	51	51	66	11	6	2			
. southwickii	1	1	1	2	2	2							2	2	2			
. species	2	2	3	3	3	5				2	2	4	1	1	1			
. webberri	10	10	10	15	14	14	3	4	1	3	8	11	9	2	2			
Total	171	165	163	271	263	252	50	60	11	105	119	158	125	83	83			

TABLE III.—*Showing the occurrence and destructiveness of the diseases*

Rank	1922		1923		1924	
	Occurrence	Destructiveness	Occurrence	Destructiveness	Occurrence	Destructiveness
1	Canker	Bark-rot	Canker	Bark-rot	Canker	Bark-rot.
2	Mottled leaf	Pink disease	Mottled leaf	Pink disease	Mottled leaf	Pink disease.
3	Bark-rot	Foot-rot	Bark-rot	Canker	Bark-rot	Canker.
4	Foot-rot	Canker	Pink disease	Mottled leaf	Pink disease	Foot-rot.
5	Pink disease	Mottled leaf	Foot-rot	Foot-rot	Foot-rot	Mottled leaf.

TABLE IV.—*Showing the average per cent infection to bark-rot of the different species*

Species	1922	1923	1924	Average
C. aurantium	10.00	10.00	20.00	13.33
C. aurantifolia	45.00	65.00	60.00	56.66
C. excelsa	12.50	62.50	75.00	50.00
C. hybrid	33.33	66.66	50.00	49.99
C. hystrix	7.69	26.92	30.76	21.79
C. limonia	62.50	50.00	37.50	49.66
C. longispina	33.33	0	66.66	33.33
C. maxima	30.55	22.22	40.27	31.01
C. medica	75.00	83.33	62.50	40.27
C. miary	0	0	50.00	16.66
C. mitis	20 00	20.00	50 00	30.00
C. micrantha	50.00	0	0	16.66
C. nobilis	23.68	11 11	45.83	26.87
C. sinensis	38.04	38.04	29.76	35.28
C. southwickii	100.00	100.00		100.00
C. species	0	25.00	25.00	16.66
C. webberri	38.88	27.77	22.22	29 62

TABLE V.—*Showing the treatment of bark-rot with carbolinium*

P. I. No.	Variety name	Kind of stock	Extent of injury	Remarks
	Citrus aurantifolia			
1749	Mindoro	O	Severe	Died of bark-rot in May, 1924.
1749	Do.	O	do.	Still living but in a dying condition.
901	Dayap	O	Slight	Recovered and in good condition.
901	Do.	O	do.	Do.
901	Do.	O	do.	Do.
3670	Trinidad	Cn	do.	Do.
3669	Everglade	Cn	Severe	Do.
5163	Tahiti	O	Very slight	Do.
5176	Lime	P	Slight	Do.
4827	Lombog	P	Severe	Still living but in a dying condition.
	Citrus aurantium			
1638	Sour orange	O	Very slight	Recovered and in good condition.
2662	Do.	P	Slight	Do.
	Citrus excelsa			
3888	Le Nestour	Lr	Severe	Died of bark-rot in May, 1924.
3665	Lemon-real	Lr	do.	Died of bark-rot in March, 1924.
3841	Tanchan	P	do.	Died of bark-rot in November, 1924.
	Citrus hystrix			
2535	Colo-colo	Cn	Very slight	Recovered and in good condition.
2535	Do.	Cn	Severe	Do.
3668		Cn	Very slight	Do.
4214	Camugao	Lr	Slight	Do.
4225	Calo-oy	Lr	do.	Do.
4225	Do.	Lr	do.	Do.
4824	Canci	P	Very slight	Do.
5178	Colobot	P	Slight	Do.

TABLE V.—*Showing the treatment of bark-rot with carbolineum*—Continued

P. I. No.	Variety name	Kind of stock	Extent of injury	Remarks
	Citrus limonia			
708	Lisbon	P	Slight	Recovered and in good condition.
	Rough lemon		do	Do.
5175		K	Very slight	Do.
	Citrus longispina			
3658	Camisan	Lr	Slight	Still living but in a dying condition.
4839	Do.	P	do	Recovered and in good condition.
4840	Do.	P		Do.
	Citrus medica			
1716	Citron	O	Severe	Still living but in a dying condition.
848	Murrill	O	do	Died of bark-rot in October, 1924.
848	Do.	O	Slight	Still living but in a dying condition.
4739	Pesak	SO	Very severe	Died of bark-rot in October, 1924.
	Citrus maxima			
2265	Lukban	O	Very slight	Recovered and in good condition.
1713	Triumph	O	Severe	Do.
1707	Marsh	O	Very slight	Do.
1707	Do.	O	do	Do.
1633	Case	O	do	Do.
1633	Do.	O	do	Do.
1631	Marsh	O	Slight	Do.
1632	Triumph	O	Very slight	Do.
1334	Pernambuco	Csp.	Severe	Died of bark-rot in May, 1924.
1334	Do.	O	Very slight	Recovered and in good condition.
1333	Ellen	O	do	Do.
1333	Do.	O	do	Do.
891	Pomelo	O	Slight	Do.
899	Do.	O	Very slight	Do.
2690	Marsh	P.I.	Slight	Still living but in a dying condition.
3384	Saigon	P	Severe	Died of bark-rot in August, 1924.
4118	Walter	O	Very slight	Recovered and in good condition.
4121	McCarthy	Cw	do	Do.
4125	Royal	Cmac	Severe	Died of bark-rot in May, 1924.
4125	Do.	Cmac	Very slight	Recovered and in good condition.
5152	Siamese	P	do	Do.
3442	Do.	SO	Slight	Do.
4868	Kellog	P	Very slight	Do.
	Citrus mitis			
1718	Calamondin	O	Severe	Died of bark-rot in August, 1924.
	Citrus nobilis			
1918	Dancy	P.I.	Slight	Recovered and in good condition.
1256	Ladu	Lr	do	Do.
744	Tizon	O	do	Do.
745	Medilla	Lr	Very slight	Do.
2693	King	P	Severe	Died of bark-rot in May, 1924.
745	Medilla	Lr	Very slight	Recovered and in good condition.
3383	Madurensis	Lr	do	Died of bark-rot in November, 1924.
1262	Suntara	P	do	Recovered and in good condition.
1335	Oneco	O	Slight	Do.
	Citrus sinensis			
1277	Seville	O	Slight	Recovered and in good condition.
56	Jappa	O	Very slight	Do.
1715	White Siletta	O	do	Do.
1714	Larrantha	O	do	Do.
1720	Bahia	O	do	Do.
1705	Mediterranean	Lr	do	Do.
1701	Holdfast	O	do	Do.
1636	Washington Navel	O	Slight	Do.
1637	Jaffa	O	Very slight	Do.
966	Cajel	O	do	Do.

TABLE V.—*Showing the treatment of bark-rot with carbolineum*—Continued

P. I. No.	Variety name	Kind of stock	Extent of injury	Remarks
	Citrus sinensis—Continued			
51	Valencia	Cn	Very slight	Recovered and in good condition.
51	Do.	O	do.	Do.
51	Do.	O	do.	Do.
2686	Pineapple	Cn	Severe	Died of bark-rot in February, 1924.
2697	Maltese Blood	Cn	do.	Living but in a dying condition.
3886	Du Roi	SO	do.	Died of bark-rot in May, 1924.
4117	Brown	O	Very slight	Recovered and in good condition.
4119	Dugat	Le	Slight	Do.
4119	Do.	Cw	Very slight	Do.
5177	Pongkan	Cn	do.	Do.
1258	Jaffa	O	do.	Do.
1258	Do.	O	do.	Do.
4126	Foster	O	Severe	Living but in a dying condition.
4126	Do.	O	Very slight	Recovered and in good condition.
1266	Whitaker	Cn	Slight	Do.
5188	Orange	P	Very slight	Do.
	Citrus southwickii			
2049		Le	Slight	Died of bark-rot in March, 1924.
2049		Le	do.	Do.
	Citrus webberri			
853	Alsem	Lr	Severe	Recovered and in good condition.
853	Do.	Lr	Slight	Do.
5102	Lias lemon	P	Very slight	Do.
5105	Alsem No. 1	P	Slight	Do.
5147	Alsem No. 2	P	do.	Do.

TABLE VII.—*Showing the resistant species to canker*

Species	1922	1923	1924	Average
C. aurantium	6	6	4	5⅓
C. aurantifolia	17	16	14	15⅔
C. excelsa	15	17	13	15
C. hybrid	11	4	17	10⅔
C. hytrix	9	5	9	7⅔
C. limonia	14	10	12	12
C. longispina	13	11	5	9⅔
C. maxima	10	8	16	11⅓
C. medica	16	15	8	13
C. miary	3	14	6	7⅔
C. mitis	1	1	1	1
C. micrantha	5	13	7	8⅓
C. nobilis	2	2	2	2
C. sinensis	8	7	15	10
C. southwickii	4	12	10	8⅔
C. species	12	9	11	10⅔
C. webberri	7	3	3	4⅓

TABLE VIII.—*Showing the susceptibility to mottled leaf*

Species	1922	1923	1924	Average
C. aurantium	4	2	6	4
C. hybrid	1	1	1	1
C. hystrix	5	10	10	8⅓
C. longispina	11	11	4	8⅔
C. miary	None	6	None	2
C. maxima	3	3	3	3
C. mitis	8	12	9	9⅔
C. micrantha	10	7	None	5⅔
C. nobilis	7	9	8	8
C. sinensis	2	4	2	2⅔
C. species	9	8	7	8
C. webberri	6	5	5	5⅓

INARCHING THE AVOCADO

By Jose de Leon

Superintendent, Tanauan Citrus Experiment Station

THREE PLATES

In the Philippines where the avocado is usually grown into fruiting trees, such seedling trees have important disadvantages when compared to vegetatively propagated trees. Seedling trees take from five to ten years to begin to bear fruit; they do not often come true to type; and they grow tall, thus being very susceptible to wind injury. On the other hand vegetatively propagated avocado trees bear two or four years after planting; they come true to type, so that if the parent tree that bore the scion yields excellent fruit the new tree vegetatively propagated from it will also bear fruit of the same quality; and such a tree grows into a low, though robust tree.

•There are three methods used which the writer has, so far, noted in the Philippines, in the vegetative propagation of the avocado. These are marcotting, cleft grafting and budding. The first one is, at best, a slow process,—success with it is very uncertain because not all varieties of avocado root when marcotted, and the danger from the marcots failing to grow when planted is great. The other two methods used need considerable skill to perform them successfully, and there is the rainy season, which is an unfavorable time for the operation and success of budding and grafting avocados.

A fourth method of vegetatively propagating the avocado,—inarching, has been practiced with success at the Tanauan Citrus Experiment Station. As this method offers some important advantages over the other methods now used, it is here described, in the belief that avocado enthusiasts, unfamiliar with the art of budding or grafting, may try it in propagating their favorite trees. The only serious disadvantage that the method has is that the tree which is to be propagated must be near at hand. The advantages, however, are, that it is not essential to have a rapidly growing seedling to use as stock to succeed; good results can be had in both the rainy as well as the dry season; no especial skill, tools or materials are necessary in the operation; and the percentage of success is comparatively high.

How the inarching is done.—Seedlings in bamboo pots are very conveniently used as stocks. These should have stems as large as a lead pencil or larger. The inarching may be done on the ground if the tree to be propagated has one or more branches which can be anchored low above the ground. If not the inarching can be done high up on the tree (see illustrations).

The pot bearing the seedling stock is placed firmly on the ground or hung on a branch near the twig to be inarched. A healthy looking twig is selected as the scion, and after interfering leaves have been cut off the bark on the sides of the stems of the stock and of the scion that face each other is sliced with a knife to a length of about two inches. The cambium layer is further removed on these sides by scraping them to the wood.

The two stems are then brought together, care being taken to put the scraped sides of the stock and scion into close contact. Any soft material which will last two months will do for tying the stock and scion firmly together. However, ordinary budding tape, if available, is the most desirable material because of its adhesiveness, which helps in tying the two stems firmly and quickly.

In four or five weeks the two stems will have partly united, as shown by a callous growth along the wound. To induce the flow of sap from the scion to the stock and vice versa, a cut about a third of the stem in depth is made into the wood of the stock about 2 inches above the inarch union, and also into the wood of the scion one or two inches below it. This operation is repeated two weeks after, making the same cuts deeper. In another two weeks time, the scion can be severed from the parent tree. Half of the foliage of the scion should be cut off to reduce transpiration. It is advisable at this time to keep the inarched plant in a cool, shady place and its watering should be regularly attended to.

If after one or two weeks the scion has not wilted or died, the portion of the stock above and the portion of the scion below the inarch union should be carefully cut off close and the cut surface then painted with white lead or asphaltum paint. The inarched plant may be planted out in the field as soon as one or more new shoots have matured.

Avocado inarching is more easily done during the wet than during the dry season because, at that time, the plants keep on growing well without needing watering, and moreover the new inarched plants are not so liable to wilt and die then but are very delicate during the dry season.

PLATE I. Inarching from a low growing branch of avocado

PLATE II. Inarching on a high branch of an avocado tree

PLATE III. Inarched Lyon avocado plant ready to be set out in the field

The Philippine Journal of Agriculture

[Formerly THE PHILIPPINE AGRICULTURAL REVIEW]

VOL. I THIRD QUARTER, 1930 No. 3

THE PRESENT STATUS OF STAPLE-CROP PRODUCTION IN THE PHILIPPINES

WHY DO WE STILL HAVE TO IMPORT LARGE QUANTITIES OF FOODSTUFFS, WHICH WE ARE PRODUCING HERE?

By MANUEL L. ROXAS

Director of Plant Industry

ONE PLATE

INTRODUCTION

Attention has been called repeatedly to our large importation of agricultural products that we can very well grow here, because our soil and climatic conditions are so diversified, that we can find places anywhere well suited to the raising of those products. Since there is keen interest in the local production of these imported articles, it seems timely to analyze some of the fundamental causes of this importation.

OUR IMPORTATION OF PLANT PRODUCTS

Published customs figures show large amounts of rice, fresh fruits and vegetables valued at over ₱25,000,000 which we import to the local market. For a background for the discussion that follows, the values of the imported commodities are given in Table I:

TABLE 1.—*Ten-year average value of imported products into the Philippine Islands arranged in order of importance*

Crops		Value (1920–29)	1929
1. Cleaned rice		₱9,406,700.00	₱11,620,026.00
2. Tobacco		4,127,000.00	3,541,455.00
Tobacco leaf	₱1,138,000.00		1,180,893.00
Cigars	400.00		39.00
Cigarettes	2,058,700.00		1,251,798.00
Chewing	760,900.00		1,016,269.00
Smoking	173,100.00		92,054.0
All others	900.00		402

TABLE 1.—*Ten-year average value of imported products into the Philippine Islands arranged in order of importance*—Continued

Crops		Value (1920–29)	1929
3. Vegetables		₱3,582,500.00	₱4,326,640.00
Cabbages	₱145,600.00		191,344.00
Garlic	169,200.00		191,310.00
Onions	578,000.00		708,146.00
Irish potatoes	682,700.00		655,122.00
Sweet potatoes	7,400.00		6,090.00
All other fresh vegetables	119,600.00		169,955.00
Canned, dried, pickled, sauces, etc	1,880,000.00		2,404,678.00
4. Fruits and nuts		2,409,800.00	3,349,768.00
Oranges	478,800.00		828,918.00
Pomelos	13,700.00		16,338.00
Lemons	78,400.00		114,264.00
Other fresh fruits	678,000.00		1,214,505.00
Peanuts	300,800.00		256,833.00
Fruits: dried, preserved, pickled, etc	861,100.00		918,910.00
5. Coffee		1,482,600.00	2,045,697.00
6. Cacao		1,249,700.00	1,547,253.00
7. Peanut oil		541,300.00	570,458.00
8. Spices		123,600.00	146,934.00
Pepper	82,000.00		120,540.00
All others	41,600.00		26,394.00
9. Castor oil		38,400.00	50,048.00
Total		22,911,600	27,198,264

Practically all of the products listed in Table I are being produced in the Islands, but in insufficient quantities.

RICE

Table I shows that we have imported an average of about nine and one-half million peso worth of cleaned rice each year in the last ten years, and that in 1929 our importation was valued at ₱11,626,000.

Our rice production for the past three years, 1927 to 1929, was in the neighborhood of one billion, four hundred million kilograms, or 25 million cavans, valued at about ₱200,000,000.

The amount of cleaned rice imported in 1929 was 105,000,000 kilos, valued at ₱11,626,000, or 8 per cent in weight of our production and only about 4½ per cent in value, f.o.b., Manila, which shows that the value of the imported rice is well below that of the local product.

Our annual consumption of cleaned rice estimated at 2.6 cavans per capita, was in round numbers 27,000,000 cavans. This figure is based on a rice eating population of about 10,400,000. Comparing this with production, we find that for the last three years, from 1927 to 1929, we raised 93 per cent of what we consumed. However, for 1930 a slight surplus production has been predicted.

A still more interesting comparison is the production by provinces, (see map) given in Table II, which shows that 17 ·ovinces out of 49 produce more than they consume, while rest still has to import. Manila heads the list of importers

followed by Cebu, Batangas, Leyte, Occidental Negros, Samar, Albay and Bohol, in the order named. Some of these provinces, provided proper incentives were given, should be able to produce at least all the cereals that they need. Take, for instance, Samar and Leyte. Leyte, a big province and, relatively speaking, thickly populated, still has tens of thousands of hectares of unoccupied land suitable for rice. So has Samar. Both provinces are within the typhoon belt and should produce crops like rice which can be grown outside of the typhoon period. But the people of Leyte, like those of Samar, still prefer coconuts to any other crop, although the typhoons which annually visit the two provinces, reduce their production of coconuts so that the people are often on the verge of famine. If, instead of planting coconuts, the people were to plant more rice and corn or such other crops as peanuts, mongo or any of the many agricultural products we are importing, greater prosperity would come to these Islands. This would be the most logical way for the people of Leyte and Samar to overcome the effect of the yearly visitation of typhoons. Both provinces have regular steamship connections with Cebu. Cebu has connections with Iloilo, Negros, Bohol, Misamis and Agusan. The importation of rice into all these places amounts to more than five million cavans. Leyte and Samar could very well supply a large part of that amount.

Increased rice production must be stimulated in the different provinces of the Philippines. There is a certain minimum price of rice which will enable rice growers to make a profit. The Government should see to it that this minimum price can be assured the rice growers under normal conditions by preventing low-priced rice from neighboring countries with much cheaper labor to compete with the local product. Hence the necessity of protective tariff on rice.

A conveniently high tariff wall, however, is not the only means that will insure profit to rice growers. Improvement of transportation facilities, prevention of rice manipulation by dealers, better credit facilities and, last but not least, proper cultural methods (with better varieties, fertilizers, etc.) are all necessary to insure a reasonable profit to the growers.

CORN

Although corn is produced in the Islands, having been introduced by the Spaniards from tropical America, and is now the staple food in certain provinces, like Cebu, Bohol, northern Mindanao, Cagayan and Isabela, yet many may be surprised to

know that our importation of this product is steadily increasing so that in 1929 we imported over nine million and one-half kilograms valued at close to ₱700,000. This seems to be a reflection on our farmers. Why, for instance, should Cebu, one of the greatest consumers of corn, still have to import this product from the Dutch East Indies by way of Hongkong?

The corn industry of Cebu, which in former years produced sufficiently for the people, is on the downward grade. This decline in corn production is the direct result of the exhaustion of the soil fertility, not so much because of the continuous growing of corn on the same land, as of the eroding effect of the rains on the rolling corn fields. This erosion has taken place at a rapid rate and has resulted in a poor worn-out soil. Now the big land owners of Cebu find that the rolling fields are best planted to coconuts. It is not necessary to terrace the land, for the roots of the coconut naturally help in retaining the surface soil and this retards erosion.

To meet the need of the people of Cebu for corn and to prevent importation from foreign lands, one of two things may be done. Either the corn culture in Cebu may be improved which would require that the surface soil of the fields devoted to corn should be conserved by terracing as in Java and by the use of fertilizers and manures. Cebu is very thickly populated and improvement in this direction should be perfectly feasible. Or if the land owners consider it more profitable to grow coconuts or some fruit trees, corn may be imported from other islands. Transportation facilities should then be developed so that corn and other products needed by Cebu could be imported from Leyte and Mindanao, where rich virgin lands are available and where large quantities of corn can be produced.

One factor that decreases corn production is the prevalence of diseases and pests. Even now, in the Cotabato Valley where corn grows luxuriantly, the downy mildew is very much in evidence. Corn borers and many insect pests likewise reduce the production. The planters must be helped to fight these pests and diseases if corn production is to be encouraged. After the production of corn has been encouraged so that the people of the corn-consuming provinces will be assured of a steady local supply, complete prohibition of corn importation should be advocated.

VEGETABLES

The total importation of fresh vegetables into the Islands has averaged for the past ten years more than three million

and one-half pesos. The importation in 1929 was valued at close to ₱4,000,000, showing a steady increase in our importation. We imported principally cabbages, garlic, onions, Irish potatoes and even sweet potatoes. Yet these same commodities are produced here. The yearly production of cabbages amounts to over one million kilograms valued at more than ₱200,000. Our production is valued at 150,000 pesos or three fourths as much as is imported. In other words if the importation of cabbages from China is to be stopped production would have to be almost doubled. The principal producers are the Mountain Province, Bohol, Pangasinan, Ilocos Sur, and Nueva Ecija. The greatest drawback to cabbage culture in the Philippines is the presence of insect pests, particularly the diamond-back moth. If the production in the Mountain Province, which, because of its climate, would be a most suitable place to grow this commodity, is to be increased, it will be necessary to help the cabbage growers in waging an intensive campaign against insect pests.

Of garlic ₱200,000 worth was imported in 1929, although we produce garlic ourselves. Our yearly production amounts to about 87,000 liters, mostly green garlic.

The value of the onions imported in 1929 was over ₱700,000, mostly of the Bermuda kind. We produce the native onions generally consumed by the poor, but so far we have not been successful in obtaining any crop of the Bermuda, which requires very intensive cultivation and above all an abundance of organic matter in the soil. The usual practice in the Philippines is not good enough for the Bermuda.

Of Irish potatoes we import more than ₱650,000 worth, mostly from Japan. In the Mountain Province, southern Luzon, Leyte, Nueva Vizcaya, Oriental Negros, and Cagayan, about ₱45,000 worth of it are raised. Irish potatoes require intensive cultivation and proper disease and pest control measures.

Sweet potatoes are still imported although the Philippines are great producers. The value of the importation is but a very small percentage of present production. There is no valid reason why it should not be stopped. As in the case of many fruits and other vegetables, the main cause of this importation is that the local producers do not cure their products and otherwise prepare them properly for the market. Vegetables and fruits ordinarily go direct from the farm to the market. This is true of sweet potatoes, oranges, mangoes, bananas, garlic, and onions. In many progressive countries which export their

vegetables abroad, their products receive special treatment; they are properly cured, wrapped and packed, with a view to maintaining their keeping qualities and attractive appearance.

We are now talking of extending our foreign markets for some of our products, such as bananas and mangoes. One of the very first steps that we must take if we want to make this scheme a reality is immediately to establish trial-stations for the proper curing and preparation of these products for export. After sufficient information has been obtained as to the best conditions and methods for curing, the next step would be to induce firms to establish commercial curing sheds and cold storage in centers of business like Manila, Cebu, and Iloilo.

Of canned and dried pickles and other preserved foodstuffs, we are now importing quantities valued at close to two million and one-half pesos. The Bureau of Science is now waging an intensive campaign all over the Islands to teach the people the accepted methods of food preservation. This will, undoubtedly, help in cutting down our importation of preserved food, though it cannot be expected that by stimulating food preservation as a household industry we shall entirely cut out such importation. Food preservation, as a household industry, can in no way compete with food preservation by commercial packing houses. The needs of the people in cheap canned goods can only be met by volume production, which will enable the sale of the product at prices within their reach.

FRUITS AND NUTS

Over ₱800,000 worth of oranges, ₱16,000 worth of pomelos, ₱115,000 worth of lemons, ₱1,200,000 worth of other fresh fruits,[1] ₱256,000 worth of peanuts and close to one million pesos' worth of dried, preserved, and pickled fruits were imported in 1929. With the exception of fruits almost exclusively raised in the temperate zone, such as apples, pears and the like, all the others are produced here and could be produced plentifully. Whether we shall ever actually produce all that we consume of these commodities will depend a great deal on the education of the fruit growers. Fruits, like oranges, pomelos and lemons, can only be grown profitably over long periods with the best of care and the most intensive cultivation.

[1] These are mostly grapes, grapefruits, apples, strawberries, plums, blackberries, lychees, mangosteens, peaches, pears, apricots, melons, figs, and dates. With the possible exception of peaches and dates, all the others can be grown in some localtiies, like Baguio, Lipa, and Bukidnon.

The profits to be derived from these fruit trees, if given the most intensive cultivation, including control of diseases and pests, by annually spraying the trees with insecticides or fumigating them in the California approved method, would be tremendous.

In California farmers owning but 16 hectares of fruit orchards enjoy incomes that put to shame that of an average well-to-do sugar-cane planter in Negros. The California 16-hectare landowners live in luxury not even dreamed of by a Luzon cane planter owning 250 hectares of sugar-cane plantation. For the fruit orchards elsewhere receive care such as is given a prize race horse or a pedigreed purebred dairy cow. The orchards are irrigated, fertilized heavily, mulched annually to increase the organic matter in the soil. Every tree pedigreed, and, most important of all, regularly sprayed every year or fumigated or both to keep out diseases and pests. Contrast this with the almost wild condition of mandarin trees in Batangas. No wonder that such an industry is declining. If the cost of the care that is given by the California grower to each tree were out of proportion to the returns given, perhaps it would be folly to speak of intensive cultivation in the growing of fruit trees, but the fact is that all properly cared for trees return up to 1,000 per cent on the investment.

Locally, the situation is like this: It is not unusual for a Batangas mandarin owner to get 20 to 50 pesos from one accidentally well developed tree. With such an income, if the productivity of the tree could be maintained year in and year out, even if a regular application of fertilizers, and treatment for pests and diseases costing but a few pesos per tree per year are needed, raising oranges will still be a very good business. Only oversight of the canons of good farming is keeping the mandarin owners from fertilizing and otherwise giving proper attention to their trees. When, therefore, the owners of fruit orchards in the Philippines shall have learned to care for them in the approved California way, great progress will be accomplished in making the country self-sufficient in ordinary fruit supply.

COFFEE AND CACAO

Of coffee, cacao and other products, we are also importing large amounts every year. In 1929, we imported over two-million-peso worth of coffee, over one and one-half million pesos' worth of cacao and one-half million pesos' worth of peanuts. All these, provided proper care were taken of them,

could be grown here extensively and are actually growing to a certain extent. The coffee plantings are now being extended fast. Cacao is a harder tree to grow, but there are certain places which are eminently suited to its culture.

About ₱120,000 worth of pepper and ₱26,000 worth of other spices were imported in 1929. Particularly note pepper. This can be grown very well and profitably as an intercrop for coffee and coconuts, especially in the coconut regions where the rainfall distribution is more or less uniform. Because of our peculiar relations with the United States, which will probably be maintained for some time, it is pertinent to mention that North America consumes over $10,000,000 worth of pepper every year. It would be a very good thing if the Philippines could start raising pepper on a large scale to supply the demand of the local market and a part of the American market, now that coconut owners are looking for some product that could be intercropped with coconut.

TOBACCO

It seems absurd that the Islands should import tobacco, but the fact is that in 1929 the importation of tobacco amounted to three and a half million pesos' worth. The fact is that, for the production of cigars, there is a necessity for importing the wrapper tobacco which up to the present time cannot be supplied by local producers although encouraging results in the development of native leaf wrapper tobacco have been obtained. The other explanation is the consumption of American cigarettes. The imported cigarettes with their peculiar aromatic taste and attractive containers seem to hit the fancy particularly of the younger people. Intensive advertising of course plays a part. Not only good wrapper leaf can be produced in the Philippine Islands but also cigarette tobacco for the production of aromatic cigarettes. The production, however, requires intensive specialization and adequate capital, which the ordinary tobacco grower does not possess. The production of wrapper tobacco has been proved beyond doubt as practicable and there is an increasing area every year in the Cagayan Valley. The production of cigarettes which is much easier, requires the combined efforts of the producers and the cigarette manufacturers, for while it is possible to produce cigarette tobacco in any quantity desired, it is necessary for the manufacturers to develop fancy products with high quality cigarette wrappers and attractive containers equal

at least to those of the imported cigarettes and resort to agressive advertising.

CONCLUSION AND RECOMMENDATION

In conclusion, it may be stated that if we want to stop our importation of products which we can well grow here and are now growing, though in insufficient quantities, it will be necessary for us:

First, to induce growers to adopt much more intensive cultural methods for their crops, which means the proper use of fertilizers, irrigation, mulching, and the control of insect pests and diseases.

Second, to properly prepare the products for the market—curing and packing, involving the establishment of commercial curing and packing houses and cold storage.

Third, to help the farmers who are just beginning to raise a new product to market it, while his volume of production is still too small to attract buyers to his place.

The third recommendation is neccesary as it has happened that farmers have been induced to raise certain commodities with a promise of a good market for them, only to find that, because of their small volume of production in the beginning, no commercial firm would handle their products for them. If it means to stimulate the production of certain commodities, the Government should, in the initial stages, help the producers market their small volume of products and continue extending such help until the volume has become large enough to attract commercial houses to establish regular channels from the place of production to business centers. Unless all this is done it will be hard to establish many an industry in the Islands.

Fourth. To make studies in an institute of investigation for agricultural industries. Among these studies would be on the following:

1. The proper treatment, curing and packing of fresh mangoes to prolong their keeping qualities and improve their appearance.

To export mangoes to the United States, it will be necessary to know how to keep mangoes for the time necessary to ship them and market them abroad. At present there are in the different parts of the Islands close to 800,000 mango trees about one-half of which now producing over 100,000,000 fruits. This is only at the average rate of about 250 mangoes per tree. When all these trees come into bearing, the production will be

increased ten-fold. It will then be necessary for us to invade foreign markets to dispose of them. The problem of keeping mangoes in cold storage has never been studied systematically and the few who have exported them have not entirely succeeded in placing in the American market fresh mango fruits with the excellent flavor and keeping quality familiar to local consumers. The problem of keeping fresh fruits under certain conditions has been studied in other countries in connection with other fruits, such as the banana, with success. It certainly should be studied for our premier fruit, if we ever hope to establish a market for it abroad. It is generally accepted that the Philippine mango is the best in the world, and this quality should be capitalized.

2. The same thing may be said of bananas. We can and should export some of the finest bananas produced in the Islands, like the "lacatan" and "bongolan". Many studies of bananas have been conducted in the West Indies and Central America, which supply most of the American markets. Bananas are shipped in bunches specially treated and properly wrapped in perforated paper bags. By storing them at low temperatures in cooled rooms, ripening may be retarded during their transport over long distances. They are afterwards artificialy ripened at their destination. Worthy of note is a Philippine variety imported into the West Indies and Central America through the pathologist of the American Fruit Packing Corporation, which has become promising and may replace the Gross Michel, the standard export variety of Central America. The Gross Michel is susceptible to the so-called Panama disease, while the "lacatan" is very resistant. The "lacatan" is one of our best varieties in the Philippines.

Methods for improving the handling of Philippine bananas must be studied both for local use and for export.

3. Similar problems which require the establishment of experimental cooling rooms for the curing and utilization of other plant products, should be studied by an institute of investigation for plant industries.

Some of these are:

(*a*) Proper curing and packing of sweet potatoes

(*b*) Curing and drying of peanuts

(*c*) Methods of curing packing and preparing lanzones for shipment to long distances, with a view to keepiing a supply of this product throughout the year.

A continuous supply of certain fruits may be obtained by planting them in regious where the fruiting season vary. For instance, lanzones in Luzon fruit only from August to November; in northern Mindanao from April to October, twice a year. With proper curing and preservation of the fresh fruits, the Philippines could have lanzones throughout the year.

If we are to produce other commodities imported in large amounts, such as Irish potatoes, bananas and a host of others, one of the important steps to take should also be to learn about their curing and preparation for the market, which can best be done in an institute of investigation for plant industries.

That such studies are essential to our agricultural development may be shown by the following instance: In the Province of Batangas a year and a half ago the people were induced to raise peanuts. The first year they raised peanuts valued at ₱10,000. The amount was absorbed by the local market for immediate use. However when production went over the ₱100,000 mark, part of the crop had to be stored, but it was found that the local product completely failed in keeping qualities because it was not properly cured. As a consequence the enterprise fell down flat, and we are still importing the foreign product which has better keeping qualities due to proper curing.

Our local production of sweet potatoes is not increasing beyond the amount directly consumed by the rural population, and they cannot be shipped long distances due to poor keeping qualities. Again, the local product is not properly cured. The Moros of Lanao have been known to be large producers of sweet potatoes. Agents of the Bureau of Plant Industry some years ago induced them to increase their production for the Manila market, but improperly packed and not cured, the sweet potatoes shipped to Manila did not find acceptance in this market. Most of them rotted.

Mandarins from Batangas are sold in the local market as fast as they are gathered from the trees. After the orange season one cannot usually find locally produced oranges. On the other hand oranges from China and Calfornia are available almost the whole year around. The California oranges are handled by commercial packing houses, and pass through an elaborate process of cleaning, washing, sweating, disinfecting, curing and packing. California oranges sold in the Islands sell from three to four times as much as the local product so that it is very evident that such a process of curing and preparation for the market will pay.

TABLE 2.—*Showing the production, importation and consumption of rice for the 1929, arranged from the highest surplus to the greatest shortage*

[All figures in cavans]

Provinces	Population	Production expressed in terms of—		Rice consumption	Rice surplus or shortage	Cleaned rice importation
		Rough rice	Cleaned rice			
1. Nueva Ecija	269,407	8,739,200	4,369,600	667,818	+3,701,782	....
2. Pangasinan	712,767	7,852,000	3,926,000	1,756,765	+2,169,235	....
3. Tarlac	238,289	2,868,200	1,334,100	576,690	+ 857,410	....
4. Bulacan	294,465	2,006,800	1,003,400	666,336	+ 337,064	....
5. Ilocos Norte	273,989	1,678,000	839,000	603,375	+ 235,625	....
6. Capiz	354,282	1,811,000	905,500	694,894	+ 210,606	....
7. Lanao	98,893	792,400	396,200	220,942	+ 175,258	....
8. Cagayan	255,042	1,252,200	616,100	442,499	+ 173,601	....
9. Nueva Vizcaya	39,923	505,400	252,700	88,228	+ 164,472	....
10. La Union	214,181	1,259,800	629,900	471,807	+ 158,093	....
11. Bataan	70,825	577,500	288,750	152,917	+ 135,833	....
12. Zambales	113,962	644,400	322,200	239,885	+ 82,315	....
13. Marinduque	94,547	457,400	228,700	172,615	+ 56,085	....
14. Mindoro	98,893	490,100	245,050	194,615	+ 50,435	....
15. Iloilo	619,026	2,519,900	1,259,950	1,231,534	+ 28,416	139,877
16. Mountain	173,968	809,300	404,650	381,840	+ 22,810	....
17. Abra	103,729	371,600	185,800	183,895	+ 1,905	....
18. Batanes	13,824	1,200	600	11,257	— 10,657	....
19. Bukidnon	52,257	80,900	40,450	73,479	— 33,029	....
20. Pampanga	324,889	1,544,000	772,000	806,242	— 34,242	....
21. Surigao	147,171	493,000	246,500	291,889	— 45,389	....
22. Cavite	191,449	833,000	416,500	462,205	— 45,705	....
23. Agusan	56,654	143,700	71,850	124,761	— 52,911	....
24. Davao	122,369	337,200	168,600	247,123	— 78,523	8,393
25. Camarines Sur	279,589	1,109,500	554,750	641,614	— 86,864	....
26. Antique	199,368	524,200	262,100	349,547	— 87,447	....
27. Palawan	75,570	80,100	40,050	144,576	— 104,526	....
28. Rizal	271,509	1,065,700	532,850	645,570	— 112,720	....
29. Camarines Norte	77,621	104,000	52,000	170,733	— 118,733	....
30. Ilocos Sur	267,489	832,700	416,350	542,984	— 126,634	....
31. Isabela	153,629	181,500	90,750	221,735	— 130,985	....
32. Romblon	90,098	100,900	50,450	190,595	— 140,145	....
33. Zamboanga	181,104	294,100	147,050	307,361	— 160,311	65,301
34. Cotabato	184,910	411,100	205,550	373,423	— 167,873	....
35. Masbate	111,064	51,200	25,600	209,797	— 184,197	....

36. Misamis	267,735	389,900	194,950	381,538	— 186,588	....
37. Laguna	237,167	748,400	369,200	603,607	— 234,407	....
38. Oriental Negros	331,795	171,600	85,800	353,754	— 267,954	....
39. Sulu	183,788	67,100	33,550	312,994	— 279,444	2,806
40. Sorsogon	213,977	307,400	153,700	439,665	— 285,965	....
41. Tayabas	268,224	550,300	275,150	624,108	— 348,958	....
42. Bohol	470,192	756.500	378,250	756,261	— 378,011	....
43. Albay	403,754	804,800	402,400	807,999	— 405,599	51,638
44. Samar	471,866	485,800	242,900	657,657	— 414,757	....
45. Occidental Negros	468,652	801,600	400,800	918,610	— 517,810	....
46. Leyte	742,365	1,165,400	582,700	1,121,384	— 538,684	....
47. Batangas	427,148	641,200	320,600	891,049	— 570,449	....
48. Cebu	1,087,618	103,200	51,600	747,640	— 696,040	1,017,488
49. Manila	358,270	....	....	935,085	— 935,085	546,272
Philippine Islands	12,859,333	49,786,400	24,893,200	24,112,897	+ 780,303	1,831,775

Because of the shortage of rice the consumption of this cereal in the Islands varies according to the supply, but it is estimated that about 72 per cent of the population invariably eat this grain and the remaining take corn and roots when they have to. The figures given in this table represent only the consumption of the population that habitually eat rice.

During the year 1929 there was a great reduction in the local production of corn and this necessarily increased the percentage of population that ate rice. Poultry is also fed with either rice or corn or both mixed.

The following summary gives the approximate consumption by the human population during the year 1929 considering the changes due to the shortage of corn.

SUPPLY

	Cavans
Total production	24,893,200
Total importation of rice	1,831,775
Total supply	26,724,975

CONSUMPTION

	Cavans
By people invariably eating rice	24,112,897
By corn eating people that had to take rice due to shortage of corn	1,296,408
Total human consumption	25,409,305
By poultry	1,156,270
Quantity supposed to be stored for lack of proper distribution	159,400
Grand total	26,724,975

A total production of 34,719,129 cavans of cleaned rice should have been raised in the Islands to meet the need during the year 1929, if all had eaten this grain.

FERTILIZER EXPERIMENTS ON LOWLAND RICE

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INTRODUCTION

Fertilizer tests on lowland rice at the Alabang Rice Experiment Station, Alabang, Rizal, were begun in 1916 and have been carried on as a secondary project in conjunction with other experiments dealing with rice varieties, irrigation and drainage, and cultural methods ever since. As to these tests, more or less complete reports have been submitted; and the more important results were published briefly in the form of annual reports.

As may be seen in the present article, the fertilizer work is far from being exhaustive and, indeed, it is most regrettable that the investigation has been limited in many ways. For lack of adequate space, the experiments did not carry a sufficient number of replications, a fact which made necessary the continuation of some of them for a number of years. Notwithstanding these defects, the work so far has been of some value to us in contributing something to our knowledge of rice fertilization and in opening up a new avenue to be pursued with renewed attention and efforts.

Rice fertilization in this country is a new enterprise, and can not be said to have been gone into to the extent that fertilization of sugar cane has. Thanks to the interest of the Government bureau concerned and of commercial firms dealing in fertilizers, there is now evidence that fertilization is practiced in isolated places in one of the principal rice-growing provinces. However, a great deal more remains to be done to stimulate this movement and to give the enterprise the importance it deserves.

RICE SOILS

The first-class rice soils in the Islands are alluvial clay loams, deep and low-lying, containing sufficient amounts of plant food

constituents. Examples of these may be found in the tracts of land extending from San Jose to Muñoz, Nueva Ecija. San Jose soils, which produce upwards of 55 cavans per hectare, contain some 0.13 per cent nitrogen, 0.10 per cent phosphoric anhydride, 1.54 per cent potash, 0.58 per cent humus and 3.29 per cent lime according to analyses made by the Bureau of Science. Good rice soils are also found in Bacarra, Ilocos Norte, where the influence of irrigation water and system of rotation is keeping these soils highly fertile. The San Miguel, Bulacan, soil which is noted for high production, is clayey, with a homogenous texture. It is said that this soil occurs in patches extending northward into Pangasinan Province. Generally speaking, the unirrigated clay soils of provinces around Manila have a comparatively low producing capacity. Such soils are shallow, being underlaid with adobe rock and have, through long periods of cultivation, lost considerable of their natural fertility. In the coastal plains of the Ilocos provinces are to be found coral soils which are more adapted to corn and maguey than to rice. The analysis of certain Bulacan soils producing only 20–25 cavans per hectare shows that they have about 0.113 per cent nitrogen, 0.077 per cent phosphoric acid, and 0.88 per cent potash. They are deficient in lime. The following represent the average analysis of 33 soil samples collected from widely scattered rice sections in Luzon: 0.128 per cent nitrogen, 0.095 per cent phosphoric anhydride, 0.992 per cent potash, and 0.505 per cent humus. In comparison with Hawaiian rice soils, the Philippine soils are much richer in potash, but lower in phosphoric acid. In many analyses, the Philippine and Hawaiian soils are found in close agreement, yet some Hawaiian soils contain much larger quantities of phosphoric acid. As to the apparently sufficient amount of nitrogen in Hawaiian soils, Kelley(1) believes that nitrogen is the most important requirement of those soils. Jack(2) considers first-class soils are clayey containing 0.2 per cent nitrogen, some 0.07 per cent phosphate, and 0.500 per cent potash. In second-class soils, these constituents are present in the proportions of 0.117 per cent nitrogen, 0.004 per cent phosphoric acid, and 0.200 per cent potash. The proportion of clay is taken as an index in determining the value of a rice soil. In Philippine soils, silt predominates over clay. Perhaps, though, the amount of colloidal clay has not been entirely recovered by the ordinary method of mechanical analysis, for with a number of heavy soils the analysis has indicated

the amount of silt to be 40 per cent and that of clay, 20 per cent.

The quantities of plant food removed by the rice crop from the soils have been variously reported by several investigators. Sen(3) of India estimates that 900 lbs. of dry grain takes away from one acre of soil 29.33 lbs. of nitrogen, 9.46 lbs. of phosphoric acid, and 49.69 lbs. of potash, the corresponding amounts per hectare being 21.8, 10.6, and 59.6 kilos, respectively. Utilizing the figures given by Krauss(7) for Japan, an ordinary Philippine crop of 35 cavans of palay weighing 1,525 kilos would appropriate from one hectare something like 20 kilos of nitrogen, the same quantity of potash and half as much phosphoric acid.

GENERAL METHODS USED

The soil concerned in this investigation was chiefly the Alabang soil, a heavy clay, with an impervious substratum. The experimental field is diked. The area of one paddy varies from 200 to 300 square meters. Unless otherwise stated, the "plots" in the experiments are taken to mean diked paddies. The field was given more thorough preparation than is usual with the farmers. Plowing was done once—rarely twice—after which the field was allowed some time for the vegetable matter to decompose. Four harrowings were usually given. The first was to break the clods; the second, crosswise to the first, to break and press the clods down into the water. The subsequent harrowings were applied to puddle the soil and to level the surface of the paddy. The crops were transplanted. The seeds were sprouted for 36 hours and then sown in seed beds in a muddy state. Transplantation usually took place a month from the soaking of the seed.

In planting, clumps of seedlings were put in. The number of seedlings per hill varied from 3 to 8. The number of plants which lived to maturity was determined in a separate investigation to be 5 to 6. The distance of planting was approximately 22 centimeters.

EXPERIMENTS AND RESULTS

The experiments herein reported may be classified into six different groups, namely:

I. Fertilization of seed beds
II. Liming of paddy soil
III. Quantity tests of ammonium sulphate
IV. Fertilizer constituents tests
V. Tests with complete fertilizers
VI. Organic fertilizers tests

It should be stated, before proceeding with the discussion, that the reports of Burton(4) on "Fertilizing of seed beds," and on "Liming of replanted seed beds," will be reviewed in this report as Experiments 1 and 3, being a part of the station's work. Experiments 14 to 18, inclusive, were performed with the coöperation of Menzi & Co., Inc., who furnished the necessary materials and the skeleton plan.

I. FERTILIZATION OF SEED BEDS

EXPERIMENT 1. The object of this test was to determine what influence fertilizers have on the growth of rice in the seed bed and on the crop yield therefrom. There were seven rectangular seed beds approximately 2 by 11 meters each, separated from one another by dikes 30 centimeters broad and 25 centimeters high. These seed beds were arranged in alphabetical order.

Dried blood was applied to seed bed B at the rate of 300 kilos per hectare. Seed bed C was treated with leachings of cow manure at the rate of 4,500 kilos per hectare. Seed bed E received ammonium sulphate at the rate of 200 kilos per hectare. And seed bed F received nitrate of soda—an equivalent amount of 200 kilos per hectare. The amounts of nitrogen contained in these fertilizers are shown in Table 1. Seed beds A, D, and G were not fertilized.

Even distribution of solid fertilizers was secured by mixing fine sand previous to application. Following application, July 4, 1916, seed of Pauni rice was sown on all seed beds at a uniform rate of 43 kilos to 400 square meters.

Transplanting was done on August 2, 1916. Seedlings from individual seed beds had occupied several paddies. The field was not fertilized.

The reaction of plants to fertilizer treatments was readily manifested by the color of the leaves, and an advanced growth was noticed with plants treated with ammonium sulphate and nitrate of soda.

TABLE 1.—*Effect upon yield of fertilizing seedlings*

Kind of fertilizer	Nitrogen per hectare	Area planted	Actual yield	Yield per hectare		Difference with check	
	Kilos	*Sq. m.*	*Kilos*	*Kilos*	*Cavans*	*Cavans*	*Per cent*
Dried blood	49	588	161.9	[a] 2,753.4	63.2	—9.6	—13.2
Leaching	18	651	199.9	3,070.7	70.4	—2.4	— 3.0
Ammonium sulphate	40	710	196.6	2,769.0	63.5	—9.3	—12.8
Nitrate of soda	42	738	209.2	2,834.6	65.0	—7.8	—10.7
No fertilizer (average)	....	....	....	....	72.8	....	....

[a] 43.6 kilos of palay equal 1 cavan.

The yields of treated seedlings were lower than the average of the untreated. The average yield of the checks was 72.8 cavans per hectare and the yields of seedlings treated with dried blood, ammonium sulphate, and nitrate of soda varied within narrow limits of 63.3 cavans for dried blood to 65.0 cavans for nitrate of soda. The yield of seedlings treated with leaching did not show any significant difference from that of the check.

It is to be inferred from these results that the application of fertilizers with 40 kilos of nitrogen per hectare to the seed bed was inimical to crop yield. The immediate effect of excessive nitrogenous fertilizer was the production of heavy foliage growth. The plants became spindling and pliable and seemed to have lost much of their vigor during their seedling stage. Some noded.

EXPERIMENT 2. *Effect of ammonium sulphate on the size of seedlings in the seed bed and its relation to crop yield.*—Ammonium sulphate containing 20 per cent nitrogen was applied to seed beds at the rate of 100 kilos and 150 kilos per hectare. The application was made June 12, 1918, just before sowing to Pauni seed. When the seedlings had grown for 30 days, they were measured for heights and then transplanted to unfertilized plots. The results are given in Table 2.

TABLE 2.—*Effect of fertilizing seed bed with small amounts of ammonium sulphate*

Rate of fertilizer per hectare	Nitrogen per hectare	Average height 30-day old seedlings	Yield per hectare	Increase due to fertilizer	
	Kilos	*Cm.*	*Cavans*	*Cavans*	*Per cent*
100 kilos	20	52.8	33.2	3.5	11.8
150 kilos	30	56.6	34.8	5.1	17.2
No fertilizer	....	47.5	29.7	....	....

The seedlings dressed with 100 kilos of ammonium sulphate gave an increased production of 11.8 per cent and the seedlings treated with 150 kilos of 17.2 per cent. In this experiment the fertilized seedlings were found to be more vigorous and stocky than the untreated seedlings.

EXPERIMENT 3. *Liming of seed beds.*—To determine if liming would improve seed beds for cropping purposes after the removal of seedlings, this experiment was conducted. Two forms of calcium compounds were employed. In one seed bed the carbonate was used at the rate of 3,600 kilos per hectare

and in another burnt lime was applied at the rate of 2,000 kilos. A third bed got a mixture consisting of 1,800 kilos of calcium carbonate and 1,000 kilos of burnt lime.

The Cruz variety was sown in the seed beds in June, 1916, the seedlings having been removed in August. The Apostol seedlings were planted after the same seed beds had been prepared in the ordinary way.

TABLE 3.—*Effect of liming replanted seed beds on crop grown thereon*

Plot No.	Kind of fertilizer or amendment	Amount per hectare	Yield per hectare	Increase due to treatment	
		Kilos	*Cavans*	*Cavans*	*Per cent*
1	Calcium carbonate	3,600	44.33	9.10	25.8
	No treatment		35.23		
2	Burnt lime	2,000	48.88	18.81	62.6
	No treatment		30.07		
3	Calcium carbonate and burnt lime	1,800 1,000	49.54	15.96	47.5
	No treatment		33.58		

The two forms of lime applied on seed beds considerably increased the crop raised from them. The greatest effect is to be credited to calcium oxide applied at the rate of 2,000 kilos per hectare, the yield being 62.6 per cent more than that of the control and 36.8 per cent more than the yield obtained from calcium carbonate. It appears probable that the 47.5 per cent increase by the mixture was largely a result of the burnt lime.

In a seed bed where the growth was thick, the accumulation of acid as a result of the secretion done by the roots naturally takes place. The neutralization of the sour soil would be an important function of lime, but there are other possible ways in which it may benefit the crop, among which are the direct nutritive action, the liberation of mineral nitrogen and the synergetic relationship either in the soil solution or in the cell wall(5).

II. LIMING OF PADDY SOIL

EXPERIMENT 4. This experiment was run simultaneously with the fertilizer constituents tests in 1923, 1924, and 1926. It consisted in applying ground lime in amounts equivalent to 500 kilos per hectare.

TABLE 4.—*Yields per hectare for 3 years of plot treated with lime*

Year	Limed	No lime	Difference		Rice planted
	Cavans	*Cavans*	*Cavans*	*Per cent*	
1923	18.94	18.60	.34	2	Magasawang palay.
1924	43.69	36.61	7.08	20	Macan Cumpol.
1926	44.29	45.48	−1.19	—3	Macan Cumpol.
Average difference				6.3	

The yields varied from year to year. In 1923, liming produced a gain of 2 per cent. In the next year the increase was 20 per cent, but in 1926 it was reduced to 3 per cent below the yield of the check. The amount applied was estimated to correct a certain acidity of the soil. Rice plants, according to the observations made, appear tolerant to ordinary acidity of the soil. Doctor Alicante working along the same line in the Bureau of Science laboratory, has expressed similar views on the subject. Its effect as a buffer in fertilized soils has a different aspect, however.

III. QUANTITY TESTS OF AMMONIUM SULPHATE

EXPERIMENT 5. This test was run in conjunction with experiment 2, in 1918, to find out the relative yields of rice in plots receiving 2 different rates of fertilizer. Two paddies were given ammonium sulphate at 100- and 150-kilo rates, respectively, and one paddy was left bare. The material was lightly worked in with a native harrow (suyod) after which the rice was planted. The results of this test are contained in Table 5.

TABLE 5.—*Yields of paddies following the treatment of ammonium sulphate at 100- and 150-kilo rates*

Rate of fertilizer per hectare	Nitrogen per hectare	Yield per hectare		Increase due to fertilizer	
	Kilos	*Kilos*	*Cavans*	*Cavans*	*Per cent*
100 kilos	20	1,831.3	42.0	4.9	13.2
150 kilos	30	1,962.6	45.0	7.9	21.3
No fertilizer		1,629.2	37.1		

The 100-kilo rate had brought about 4.9 cavans and the 150-kilo rate, 7.9 cavans more than the check, with the corresponding percentages of 13.2 and 21.3. At the present price of am-

monium sulphate, however, the value of 7.9 cavans would just cover the cost of the fertilizer.

It may be noted that in Experiment 2 the resulting increase obtained by fertilizing rice in the seed bed ran in much the same order, with increased yields of from 3.5 to 5.1 cavans; yet these were obtained at the expense of much less fertilizer, for the seed bed area was only 1/25 part of the field. The economic aspect of the seed bed fertilization can be gleaned from the fact that the cost of ammonium sulphate required for 400 square meters of seed bed would amount to ₱1.05 only.

In order that a fertilizer may be taken full advantage of by the rice plant, it should be applied before the tillering period, when it is needed for the multiplication of culms. The greatest amount of protein in the rice plant was found by Suzuki (6) to be 4 to 5 weeks after transplanting, and he advises giving the fertilizer during the early growth. Seedlings grow rapidly during the seed-bed stage and large amounts of plant foods, particularly nitrogen, must be made available for the formation of leaves.

EXPERIMENT 6. The experimental plots were located on an elevated section of Extension Field B of the Rice Experiment Station where the soil is shallow, with an impervious substratum, and where seepage is great on account of the grade. It was observed that this particular place was unproductive, so it was desired to improve the crop yield by fertilization.

Sixteen paddies were taken in 4 columns and 4 rows. The 4 paddies running diagonally across the block were unfertilized and the remaining 12 paddies were given ammonium sulphate at the rate of 150 kilos per hectare, the fertilizer analyzing 18 per cent nitrogen.

1	5	9	13 Check 4
2	6	10 Check 3	14
3	7 Check 2	11	15
4 Check 1	8	12	16

DIAGRAM I.—Arrangement of paddy-plots

Planting was done in August, 1924, with seedlings of the Apostol variety and the crop was harvested in November of the same year.

TABLE 6.—*Computed yields of paddies treated with 150 kilos of ammonium sulphate*

Paddy plot No.	Yield per hectare	Difference with checks	
	Cavans	*Cavans*	*Per cent*
1	46.12	19.08	70.6
2	22.50	— 4.54	—16.7
3	21.60	— 5.44	—20.1
5	49.65	22.61	83.6
6	39.72	12.68	46.9
8	9.17	—17.87	—66.1
9	48.50	21.40	79.4
11	38.50	11.46	42.4
12	26.15	— .89	— 3.3
14	33.66	6.62	24.1
15	29.60	2.56	9.5
16	26.70	— .34	— 1.2
4-7-10-13 check's average	27.04		
Average increase due to treatment		5.60	20.7

An examination of the table shows a wide variation in the individual paddy yields, both in regard to the test and the check plots, yet it seems quite evident from comparison of averages that there was a 20.7 per cent increase due to treatment. The material advantage, however, was so small it just offset the expenses involved.

EXPERIMENT 7. This experiment was run in two series, each containing 5 paddies. The field had a slight slope. Paddies receiving the same treatment were joined and occupied the same level. The usually accepted arrangement of plots was followed by making the end plots, the checks and the intervening ones variates.

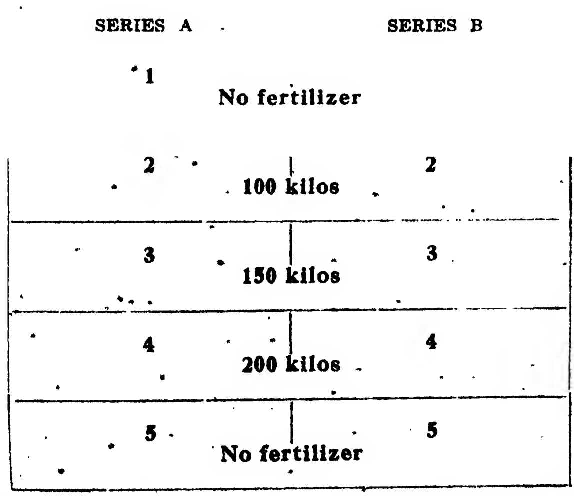

DIAGRAM II.—Showing the arrangement of plots in duplicate experiment with 3 treatments

Ammonium sulphate, 20 per cent pure, was thrown broadcast over the paddies at three rates, as follows:

Paddies A1 and B1, No fertilizer.
Paddies A2 and B2, 100 kilos per hectare.
Paddies A3 and B3, 150 kilos per hectare.
Paddies A4 and B4, 200 kilos per hectare.
Paddies A5 and B5, No fertilizer.

The fertilizer was slightly worked in with a native tooth harrow. Immediately afterwards the rice was planted. This was in July, 1925. The seed was sown in June and the crop was cut in November.

TABLE 7.—*Yields of palay resulting from treatment with 3 rates of ammonium sulphate. Apostol rice grown*

Rate of application per hectare	Average yield per hectare	Average increase or decrease with checks	
	Cavans	*Cavans*	*Per cent*
100 kilos	19.86	—.16	—.8
150 kilos	25.55	4.53	21.6
200 kilos	30.51	9.49	45.1
No fertilizer	20.19	....	....

In this experiment there was a proportionate increase of from 4.53 to 9.49 cavans in favor of 150- and 200-kilo rates. The application of 100 kilos of ammonium sulphate had a slightly negative effect.

EXPERIMENT 8. This experiment was conducted in 1926 as a repetition of Experiment 7. The same plots were prepared and fertilized with ammonium sulphate in the same manner as in 1925. Apostol rice was planted on July 26. Two days afterward the fertilizer was broadcasted in three rates as prescribed for Experiment 7.

A most favorable season had set in during the growth of the rice. The distribution of rainfall from June to November was even and the total amount was actually in excess of 370 millimeters over the average for Alabang. Consequently the plants had, by late September, manifested an abundant growth with heavy production of foliage.

Thus it will be seen by reference to Table 8 that the crop greatly exceeded that of last year and showed that the lowest rate, that of 100 kilos of ammonium sulphate, registered an increase of 20.88 cavans while that of the two higher rates produced about the same increase.

TABLE 8.—*Yields in the 1926 experiment with 3 rates of ammonium sulphate*

Rate of application per hectare	Average yield per hectare	Average increase	
	Cavans	*Cavans*	*Per cent*
100 kilos	69.88	20.88	43.1
150 kilos	70.95	22.45	46.3
200 kilos	68.70	20.20	41.6
No fertilizer	48.50	....	....

The weather exerted a great influence upon the growth of the crops in such a way that even a small amount of fertilizer was sufficient to produce the optimum grain yield and an additional amount of fertilizer to cause the crop to run to straw. The proper balance of grain and straw in a rice plant would of course vary with the different varieties. At the Alabang Rice Experiment Station the normal grain crop was found with 18 varieties in which the ratio of grain to straw was 0.66. Below or above this index the grain yield tended to fall off.

EXPERIMENT 9. This was the third year test on the quantity of ammonium sulphate fertilizer started in 1925. The same distribution of paddy-plots and rates of application as those indicated in Diagram II were followed. The rice was sown in June and transplanted in August, 1927. Eleven days after transplanting the fertilizer was applied. The crop was harvested in November, 1927.

TABLE 9.—*Yields in the 1927 experiment with 3 rates of ammonium sulphate*

Rate of application per hectare	Average yield per hectare	Average increase	
	Cavans	*Cavans*	*Per cent*
100 kilos	26.10	—1.63	— 4.31
150 kilos	52.71	14.93	39.52
200 kilos	59.53	21.75	57.57
No fertilizer	37.78	....	....

In this experiment the application of 100 kilos per hectare of ammonium sulphate gave a negative result, the check yield exceeding the test yield by a small margin. The application of 150 kilos of fertilizer, however, yielded 52.71 cavans and the application of 200 kilos, 59.53 cavans, or an increase of 14.93 and 21.75 cavans, respectively. These results are in general accord with those secured in Experiment 7 although here the production is greater and the increases for different treatments correspondingly so.

EXPERIMENT 10. This test with ammonium sulphate was conducted at Alabang, Rizal, outside of the Government farm, in coöperation with a farmer. The experimental field was dependent upon rainfall for irrigation and the soil is of the same type as the station soil. Two rates, 100 kilos and 200 kilos of ammonium sulphate to the hectare, were tried. The test was run in duplicate.

Macan was sown on June 24, 1926, and transplanted when 6 weeks old. The ammonium sulphate was applied to test plots on October 9, and the crop was harvested in the middle of December, 1926.

TABLE 10.—*Computed yields of plots fertilized with 2 rates of ammonium sulphate*

Rate of application per hectare	Average yield per hectare	Average increase	
	Cavans	*Cavans*	*Per cent*
100 kilos	36.36	1.43	4.1
200 kilos	45.32	10.39	29.9
No fertilizer	34.93	....	....

DISCUSSION OF RESULTS

The conditions under which the experiments were performed may be said to have approached normality. The experimental fields are of the same soil type and are fairly level, except that for Experiment 5. The chief rice varieties used were the Apostol and Macan, representing the early-maturing and mid-season types. Two weather fluctuations should be noted. In 1925, the experimental crop was affected by drought. On the other hand there was a well distributed and abundant rainfall in 1926.

The data for results concerning the different experiments on the quantity of ammonium sulphate fertilizer are compiled for reference in Table 11. The last column on the left presents the weighted averages of increased yields, while the bottom column gives the average yields of check plots in cavans.

TABLE 11.—*Summary of results of ammonium sulphate quantity tests in per cent gain or loss, as compared with the check*

Rate of application per hectare	Experiment 5	Experiment 6	Experiment 7	Experiment 8	Experiment 9	Experiment 10	Number of plots	Average increase
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*		*Per cent*
100 kilos	13.2	....	—0.80	43.10	—4.31	4.10	9	10.81
150 kilos	21.3	20.7	21.60	41.80	39.52	....	21	28.48
200 kilos	....	....	45.10	41.60	57.57	29.9	8	43.54
Average yield of controls in cavans	37.10	27.04	21.02	48.50	57.78	34.93	....	35.77

The data in the extreme left column are of the greatest importance, for they represent in concrete form the relative yields which may be expected to result from the application of ammonium sulphate at three different rates under Alabang conditions. They are also of practical value in that they furnish more reliable criteria for estimating the cost of fertilization than it is possible to secure from any single experiment. The application of 100 kilos per hectare produced an increase of 10.81 per cent; 150 kilos, 23.43 per cent; and 200 kilos, 43.54 per cent.

The differences in per cent gains between the stages are fairly well defined and run at a greater pace toward the larger rate of fertilization, thus indicating not only that Alabang soil needs nitrogen, but that it is likely to respond to the application of ammonium salts in greater quantity than has been provided for.

The 100-kilo rate was evidently too small, for we note that out of 5 experiments only 2 gave a real increase, one scarcely any, and 2 went lower than the checks. It may be deduced from this result that the effect of small applications was easily counteracted by the changed condition of the field, the weather, or even by an error in sampling.

The lowest increased yield produced by the application of 200 kilos of ammonium sulphate per hectare was 29.9 per cent registered by Experiment 10 on a poor soil outside the Alabang Rice Experiment Station. The highest figure was 57.57 secured in Experiment 9 under ideal weather conditions. The figures for Experiments 7 and 8 are about the average.

On the basis of average check yield of 38.77 cavans per hectare, the increase for the 150-kilo rate would be 8 cavans valued at ₱35, and for the 200-kilo rate, 17 cavans valued at ₱59, at ₱3.50 a cavan. At the present price of ammonium sulphate,[1] ₱175 a ton, it will be seen that the value of 8 cavans increase would cover the cost of 150 kilos of fertilizer and leave just enough margin to meet the freight and labor expenses. It is not profitable.

In the case of the 200-kilo rate, there was a probable increase. The money value of 17 cavans of palay was ₱59 and the cost of fertilizer only ₱35. The additional expenses for labor and transportation would not exceed ₱4, so the sum of ₱20, that is ₱0.10 for every kilo of fertilizer applied, would represent a clear profit.

[1] Since this article was sent to the press the price of ammonium sulphate has dropped to ₱125 per ton.

Ammonium sulphate is an acid-forming substance and when added to a submerged acid soil will exert a detrimental effect on the rice plant, whose tolerance to acidity is only relative. According to Krauss (7) when such soils are limed to a neutralized point ammonium sulphate exerts its greatest power. Liming may be done occasionally, say once in every 3 to 5 years. It should not be resorted to without first testing the soil for acidity, for it is known that the indiscriminate use of lime may lead to the destruction of soil humus. For the acidity test of soils, blue litmus paper may be used; also the "acid-test solution" recommended by the Bureau of Science.

IV. FERTILIZER CONSTITUENTS TESTS

EXPERIMENT 11. This was started in 1923 and was continued in 1924 and 1926. The 1925 experiment was rejected on account of exaggerated crops arising from accidental fertilization with horse manure when the army horses were pastured in the field that year. The field is situated in the neighborhood of the Rice Experiment Station in Alabang. It has a heavy clay soil like that of the station, and depends upon the rain for its water supply.

In the present experiment, as in the other two, single plots were employed except for the check, which had four. The average size of these plots was 435 square meters. Fertilizer applications were based on 20 kilos of nitrogen, 10 kilos of phosphoric acid and 15 kilos of potash per hectare, supplied in the forms of ammonium sulphate containing 20.9 per cent nitrogen, superphosphate of lime containing 22 per cent phosphoric acid and potassium sulphate containing 50 per cent potash.

The land was planted to Magasawang-Palay on August 16, 1923. Three weeks after this date fertilizers were applied as top dressing. The following data show the different treatments and their corresponding yields. Plots were harvested in November.

TABLE 12.—*Yields of fertilizer constituents test, 1923*

Treatment[1]	Yield per hectare	Increase due to fertilizer	
	Cavans	*Cavans*	*Per cent*
20 N + 10 P_2O_5 + 15 K_2O	26.22	7.62	40.9
20 N + 10 P_2O_5	26.22	7.52	40.9
20 N + 15 K_2O	23.08	4.45	23.9
20 N	28.65	10.05	56.7
10 P_2O_5 + 15 K_2O	19.52	.92	4.9
10 P_2O_5	17.86	.71	3.8
15 K_2O	20.83	2.23	12.0
No fertilizer (average)	18.60		

[1] First figures in this column denote kilos per hectare.

The data as regards the effect of phosphoric acid and potash on the rice crop fail to show any decided advantage over the check. This may be attributed to the variation which goes with the single plot test. At any rate the increase due the two elements could not be of any consequence. It was the nitrogen which had exerted a marked influence and was responsible for 7.62 cavans or 40.9 per cent increase in plots receiving a complete fertilizer, and nitrogen and phosphoric acid. The same thing may be said of the plots treated with nitrogen and potash combined, whose difference in increased yields can be narrowed down to 7.25 cavans.

EXPERIMENT 12. This was the second-year test on fertilizer constituents, performed first in 1923. In this test the materials and rates used were the same as previously. Macan Cumpol was sown in June and transplanted in August. Six days following the transplantation fertilizers were applied.

In about a month the field went dry, but this did not matter, for the crop and the fertilized plots showed signs of better growth, especially with reference to the plots where nitrogenous fertilizers were added. It was also noted that the crop lay flat in practically all the plots as a result of the heavy rainfall of November. The crop matured in December.

TABLE 13.—*Results of 1924 fertilizer constituents test*

Treatment	Yield per hectare	Increase due to fertilizer	
	Cavans	*Cavans*	*Per cent*
20 N + 10 P_2O_5 + 15 K_2O	58.07	21.28	57.8
20 N + 10 P_2O_5	49.66	12.87	35.0
20 N + 15 K_2O	51.60	14.81	40.3
20 N	51.95	15.16	41.2
10 P_2O_5 + 15 K_2O	47.06	10.27	27.9
10 P_2O_5	44.84	8.05	21.9
15 K_2O	45.11	8.32	22.6
No fertilizer	36.79	....	....

The crop this year was greater than in the preceding on account of more favorable weather. The increases due to treatments were proportionally greater.

Phosphoric acid and potash each produced a moderate increase in this experiment, amounting to about 8 cavans or 22 per cent. The combination of the two further increased the yield by about 2 cavans. As in Experiment 11 the nitrogen was the most active element. In combination with phosphoric and potash it gave the maximum yield of 58.07, that is 21.28 cavans over the average of the checks. In other instances where nitrogen was applied with other constituents, the additional yields appear to

have been entirely due to its action. The mixture of nitrogen and potash produced 51.6 cavans; nitrogen alone gave 51.95 cavans. With the combination of nitrogen and phosphoric acid, the yield was not so great, being only 49.66 cavans. The increase for nitrogen here may be put safely at 14 cavans, that is over 38 per cent.

EXPERIMENT 13. This test belongs to the series started in 1923, now in its third year. Macan Cumpol was sown in the seed bed in June, 1926. The seedlings were set out in August and on August 24, a few days after transplanting, fertilizers were applied.

Patches of excessive growth, the effect of horse manure incident to the encampment of cavalry soldiers the previous season, were carefully determined and removed at harvest time. The data herein reported pertain to the unaffected plots or portions of the experimental field.

TABLE 14.—*Results of 1926 fertilizer constituents test*

Treatment	Yield per hectare	Increase due to fertilizer	
	Cavans	*Cavans*	*Per cent*
20 N + 10 P_2O_5 + 15 K_2O	98.51	36.70	59.4
20 N + 10 P_2O_5	63.44	1.63	2.6
20 N + 15 K_2O	82.50	20.69	33.5
20 N	65.62	3.81	6.2
10 P_2O_5 + 15 K_2O	78.60	16.79	27.2
10 P_2O_5	68.12	6.31	10.22
15 K_2O	76.58	14.77	23.80
No fertilizer	61.81	....	....

The abundant and evenly distributed rainfall during the 1926 season was accountable for the heavy crop registered that year. The results should be interpreted with this fact in mind and with reservation concerning the low yields for the nitrogen-phosphoric acid plot and for the nitrogen plot. From the high yield obtained by the complete fertilizer, also by the combination of nitrogen and potash, we may presume that despite the low figures alluded to, the nitrogen element was the limiting factor just as it was in the last two experiments. The combination of the three elements brought out the greatest return, amounting to 98.51 cavans, as against 61.81 cavans of the check, with nitrogen and potash ranking second with 82.50 cavans. That potash wash a more active element than phosphoric acid in this test is suggested by the difference between their yields.

EXPERIMENT 14. The following outline will show the quantities of fertilizing materials used per hectare. Plot 1 received

60 kilos of nitrogen, 40 kilos of phosphoric acid and 48 kilos of potash. These were supplied in the form of ammonium sulphate, superphosphate, and sulphate of potash. Plot 2 same as Plot 1, but without potash; Plot 3 same without phosphoric acid; Plot 4 with potash and phosphoric acid, but no nitrogen; Plot 5, check.

The experiment was made at the Alabang Rice Experiment Station, on a stiff clay soil, containing 0.067 per cent nitrogen, 0.131 per cent phosphoric anhydride, 0.771 per cent potash, and 2.340 per cent lime. A study made of this soil shows it has low nitrifying power.(8)

The fertilizers were applied broadcast 14 days after the plots were planted to Apostol rice. At that time the land was drained of all surplus water. The surface soil was well puddled and smooth. The crop, sown in June was transplanted in July, and harvested in November, 1928.

TABLE 15.—*Yields of fertilizer constituents test with high application rates, Alabang soil*

Treatment	Yield per hectare	Increase due to fertilizer	
	Cavans	*Cavans*	*Per cent*
$60\ N + 40\ P_2O_5 + 48\ K_2O$	43.0	18.1	78.3
$60\ N + 40\ P_2O_5$	49.3	24.4	97.9
$60\ N + 48\ K_2O$	47.7	22.2	89.1
$40\ P_2O_5 + 48\ K_2O$	29.9	5.0	20.1
No-fertilizer	24.9		

There was a material gain in all plots treated with mixtures containing nitrogen. The yields from these different mixtures varied somewhat from those from the complete mixture which yielded 43.0 cavans. Nitrogen and phosphoric acid combined produced 49.3 cavans, and nitrogen and potash combined, 47.7 cavans. Compared with the check yield of 24.9 cavans, irrespective gains would be 18.1, 24.4, and 22.2 cavans. The combination of phosphoric acid and potash had increased the yield by merely 5.0 cavans.

EXPERIMENT 15. Experiment 15 was carried on at Tagudin, Ilocos Sur, on the same plan prescribed for Experiment 14. In the Tagudin experiment there were duplicate plots and each plot was about ¼ hectare in extent. The results obtained from the two series of plots were parallel, and it is therefore permissible to present the average figures.

TABLE 16.—*Average yields of fertilizer constituents test with high rates, Tagudin soil*

Treatment	Yield per hectare	Increase due to fertilizer	
	Cavans	*Cavans*	*Per cent*
60 N + 40 P_2O_5 + 48 K_2O	54.4	30.2	124.8
60 N + 40 P_2O_5	47.7	23.5	97.1
60 N + 48 K_2O	41.9	17.7	73.1
40 P_2O_5 + 48 K_2O	28.5	4.3	17.8
No fertilizer	24.2		

The rice variety used there was the so-called "Bagset" which was sown in June and transplanted August 16–17, 1928. Treatments were given 14 days after planting. The crop flowered in the latter part of October and was cut December 1st.

The average check yield was 24.2 cavans. The complete fertilizer procured the highest yield, 54.4 cavans, which meant an increase over the check of 30.2 cavans or 124.8 per cent. The mixture of nitrogen and phosphoric acid and the mixture of nitrogen and potash gave respectively 47.7 and 41.9 cavans, and the combination of phosphoric acid and potash 28.5 cavans.

The Tagudin soil is clay loam of a light brown color, underlaid with adobe rock substratum. It contains to judge from the analysis made of two samples, 0.148 per cent nitrogen, 0.128 per cent phosphoric acid, 1.63 per cent potash and 2.05 per cent lime. It has been in cultivation for many years, and the present production from information furnished by the farmers would not exceed 30 cavans.

DISCUSSION OF RESULTS

Referring to Experiments 11, 12 and 13, a comparison of the average figures shows that the complete fertilizer consisting of 20 kilos nitrogen, 10 kilos of phosphoric acid and 15 kilos of potash gave the highest yield in every experiment. The average per cent increase for three years amounted to 52.7 per cent. The increase was higher in all treatments with the nitrogen than without it. The combination of nitrogen and phosphoric acid produced an average increase of 26.3 per cent, against 32.6 per cent obtained by nitrogen and potash combined. Phosphoric acid and potash combined gave 20 per cent more grain than the check, and phosphoric acid and potash applied singly gave 9.4 per cent and 19.5 per cent.

It is to be inferred from the results that nitrogen is the first essential requirement of Alabang soil. It is not clearly indi-

cated whether phosphoric or potash is the more active, although it may be presumed that the latter secured a more steady response as far as this series of experiments was concerned. Phosphoric acid applied alone had small effect; so had potash. When combined the two advanced the crop yield to an appreciable extent, but neither showed any distinct effect when combined with nitrogen, which alone gave a greater return than when in combination with phosphoric acid or potash. As already stated the mixture of the three invariably yielded the most. The average yield of unfertilized plots for the three experiments was 24.9 cavans.

The percentages of increased yield in Experiments 14 and 15 are brought together in Table 17. The per cent of increase for complete fertilizer treatment with 60 kilos of nitrogen, 40 kilos of phosphoric acid and 48 kilos of potash was 109.3; for nitrogen and phosphoric acid mixture, 97.4; for nitrogen and potash, 78.4; and for phosphoric acid and potash, 18.6.

TABLE 17.—*Showing percentages of increased yield on Alabang and Tagudin soils, 1928*

Treatment	Increase in yield		Average
	Alabang	Tagudin	
60 N + 40 P_2O_5 + 48 K_2O	78.3	124.8	109.3
60 N + 40 P_2O_5	97.9	97.1	97.4
60 N + 48 K_2O	89.1	73.1	78.4
40 P_2O_5	20.1	17.8	18.6
Average yield of checks in cavans	....	....	24.4

It is obvious that the results are concordant and run in the same relative order for the two experiments, and the differences between stages are quite marked. The complete fertilizer leads in production, the mixture of nitrogen and phosphoric acid ranks second, that of nitrogen and potash comes next, and phosphoric acid and potash last. In the light of these results we are led to conclude that while nitrogen constitutes the first requirement of the soils under consideration, the addition of phosphoric acid plays an important part, and potash is needed the least. The comparatively low figure for the complete fertilizer in Alabang Experiment is attributable at least partly to the loss of grain when the heavy crop was beaten down by the storm of November 23–24, 1928.

The profit and loss in the application of single and mixed fertilizers may now be considered. The present Manila quotations f.o.b. per ton of ammonium sulphate is ₱175.[a] A ton of single superphosphate of lime costs ₱50, and a ton of sulphate of potash ₱147. The price of one cavan of palay may be estimated at ₱3.50. With the use of a complete fertilizer containing 20 kilos of nitrogen, 10 kilos of phosphoric acid and 15 kilos of potash (Experiments 11, 12, and 13), the increase was 13.12 cavans worth ₱46.02. This was produced at the fertilizer cost of ₱24.41, and there is therefore a margin of ₱22.61 profit. From the application of nitrogen and phosphoric acid at the rates given above, 6.55 cavans valued at ₱22.82 was obtained, which amount would come to about the cost of fertilizers and other expenses.

Greater rates of nitrogen and phosphoric acid (Experiments 14 and 15), made an attractive gain of about ₱25.60, freight charges and labor not included, however. The complete fertilizer netted less than ₱20, partly because of the high cost of potash fertilizer. No benefit accrued from the use of nitrogen and potash combined, phosphoric acid and potash combined and single elements.

V. TESTS WITH COMPLETE FERTILIZERS

EXPERIMENT 16 AND 17. The treatment with fertilizers in these two experiments was based on the application, on one hectare area, of

(1) Home-mixed fertilizer consisting of 60 kilos of nitrogen, 40 kilos of phosphoric acid and 48 kilos of potash;

(2) Brand No. 9 carrying 45 kilos of nitrogen, 45 kilos of phosphoric acid and 20 kilos of potash; and

(3) Brand No. 8 with 25 kilos of nitrogen, 40 kilos of phosphoric acid and 50 kilos of potash.

These experiments had many particulars in common with Experiments 14 and 15, having been conducted in the same fields in Alabang and Tagudin, respectively, in 1928.

TABLE 18.—*Yields of complete fertilizer test on Alabang clay soil, with variety Apostol. Single plots*

Treatment	Yield per hectare	Increase due to fertilizer	
	Cavans	*Cavans*	*Per cent*
Home-mixed fertilizer	43.0	18.1	73.3
Brand No. 9	42.5	17.6	70.7
Brand No. 8	31.1	6.2	24.9
No fertilizer	24.9	....	....

[a] See footnote on page 259.

TABLE 19.—*Yields of complete fertilizer test on Tagudin clay loam soil, with Bagset variety. In duplicate plots*

Treatment	Yield per hectare	Increase due to fertilizer	
	Cavans	*Cavans*	*Per cent*
Home-mixed fertilizer	58.7	34.5	143
Brand No. 9	76.6	52.4	217
Brand No. 8	56.4	32.2	133
No fertilizer	24.2	....	....

In both the Alabang and Tagudin experiments the home-mixed fertilizer and Brand No. 9 produced greatly increased yields, although in Tagudin the results were more pronounced. The home-mixed fertilizer and Brand No. 9 gave practically the same yields at Alabang, while in Tagudin the yield from Brand No. 9 exceeded that from home-mixed fertilizer by a wide margin. Brand No. 8 in Alabang gave more than Brand No. 9, indicating the benefit of adding from 25 to 45 kilos of nitrogen per hectare. The 60 kilos of nitrogen provided by the home-mixed fertilizer proved excessive, for the yield did not vary proportionally with the amount applied. The same thing may be said as to Tagudin, where the crop from Brand No. 9 exceeded that from the home-mixed fertilizer, and that from Brand No. 8 equaled that from the home-mixed in production. On account of the low rate of increase on Alabang soil, the balance sheet shows that the cost of fertilizers about equaled the income from Brand No. 9. Loss was incurred with the use of home-mixed fertilizer and Brand No. 8. Every treatment in Tagudin was followed by a gain, ranging from ₱48 for the home-mixed fertilizer to about ₱120 for the Brand No. 9.

EXPERIMENT 18. *Number of fertilizer applications.*—Simultaneously with the experiments conducted at Alabang, Rizal and Tagudin, Ilocos Sur, in 1928, a test on the number of applications of fertilizers was made. The materials consisted of 300 kilos of ammonium sulphate, 200 kilos of single superphosphate, and 96 kilos of sulphate of potash to the hectare.

(1) In one application:
    300 kilos ammonium sulphate
    200 kilos superphosphate
    96 kilos sulphate of potash
(2) First application:
    100 kilos ammonium sulphate
    200 kilos superphosphate
    96 kilos sulphate of potash
  Second application (14 days after 1st application):
    100 kilos ammonium sulphate
  Third application (14 days after 2nd application):
    100 kilos ammonium sulphate

The yields of the plots thus differently treated were harvested separately and computed to a one-hectare area, which appear in the table below.

TABLE 20.—*Comparative yields resulting from one and three applications of nitrogenous fertilizer*

	Tagudin clay loam	Alabang clay soil
	Cavans	*Cavans*
One application	58.3	44.8
Three applications of two weeks intervals	54.6	41.2
Increase due to one application	3.7	3.6

These results coming from experiments conducted at points situated far apart, should be valuable in showing that applying a nitrogenous fertilizer to the rice crop all at once gives a greater return than when the same fertilizer is applied in installments. The danger which attends the application of a heavy nitrogenous fertilizer lies in its power to act quickly, where soil is deeply irrigated the crop is apt to grow rank and lodge. A recent view on the property of potassium suggests small and frequent applications of potassium fertilizers as the more desirable course. In the opinion of Truog, cited by Hoagland,(9) this element subsequent to its being fixed in the colloidal complex as replaceable base, goes into more soluble form.

VI. ORGANIC FERTILIZERS TESTS

EXPERIMENT 19. *Cattle dung.*—For this series of experiments, a well rotted manure from a cattle shed kept in the compost house for some time, was used. It had never been leached, so its composition might have measured up to the common analysis of 0.4 per cent nitrogen and 0.4 per cent potash. The manure was carted to the field and plowed under when the paddies were being broken for the season's rice crop. To one plot quicklime was added when the last harrowing was being given.

TABLE 21.—*Effects upon the rice crop of cattle dung, with and without lime*

Treatment	Rate per hectare	Yield per hectare		Increase or decrease due to treatment		
		1918	1919	1918	1919	
	Kilos	*Cavans*	*Cavans*	*Cavans*	*Cavans*	*Per cent*
1. Cattle dung	13,300	31.8	38.7	—2.9	3.1	8.7
2. Cattle dung Quicklime	13,300 200	28.6	57.5	—6.1	21.9	61.5
3. Unmanured	....	34.7	35.6	....	....	....

The gain in 2 years by the first manurial treatment was 0.2 cavans; by the second treatment, 15.8 cavans. The reductions of crop by the two treatments the first year of trial is noticeable. They can hardly be accounted for by mere accident. It was possibly a case of plant starvation due to rapid transformation of ammonia nitrogen into microbial protoplasm (Niklewski) (10).

EXPERIMENT 20. *Copra cake fertilizer.*—Copra cake contains 0.4 per cent of nitrogen and at the price it is placed on the market, it is a much cheaper source of nitrogen than sulphate of ammonia and is available in greater quantities than any other native forms of organic fertilizer, except perhaps guano. Its value will be appreciated more if it is understood that the Philippine cultivated soils are often deficient in organic matter (humus) which must be added in order that the soil bacteria whose activities are vital to agriculture, may have suitable media from which to derive their energy. In Japan, it is a common practice to apply soy bean cake supplemented with ammonium sulphate and phosphate of lime. In this way soil fertility is maintained, as reflected in the heavy and stable production of rice in that country.

The series herein reported was carried on over a period of 3 years, from 1925 to 1927, to test the manurial value of copra cake at the rates of 500, 700, and 1,000 kilos per hectare. The fertilizer was applied yearly in duplicate plots about the time the land was planted to rice. The results of the first year's trial were not counted, for it was apparent that organic matter of the nature of copra cake could have no material influence on the crop directly treated but on the next. The results in 1926 therefore may be taken as mainly the effect of the 1925 applications, in other words they were residual effects. This holds good in regard to the 1927 yields. Two salient points are brought to view by these trials: First, continued application of copra cake caused the yield to rise in the second year and to decrease in the third; and secondly, the application of 500 kilos was most advantageous. Concerning the general depression in the third year, it is traceable at least partly to the accumulation of acid involved in the decomposition of organic matter in the soil, and is thus amenable to liming.

TABLE 22.—*Showing yields of copra cake tests, 1926 and 1927*

Rate per hectare	Average yield per hectare		Increase due to fertilizer			
	1926	1927	1926		1927	
	Cavans	*Cavans*	*Cavans*	*Per cent*	*Cavans*	*Per cent*
500 kilos	53.3	39.6	11.6	27.8	5.3	15.5
700 kilos	62.1	48.1	20.6	48.9	13.8	40.2
1000 kilos	59.1	43.5	17.8	42.7	9.2	26.8
No fertilizer	41.7	34.3	....	....	....	....

SUMMARY

This paper presents a review of the fertilizer work of the Alabang Rice Experiment Station during the 13-year period 1916–1928, inclusive.

Experiments were conducted dealing with fertilization and the liming of seed beds, and the application of various rates of single and combined fertilizers to the rice field.

For lack of an adequate place, the duplicate plot method was adopted for most of these experiments, the work extending over two or three years.

Certain deductions may be made from the results obtained:

1. In the fertilization of seed beds, the application of 40 kilos of nitrogen per hectare supplied by quick acting fertilizers resulted in weak, spindling seedlings, and in the reduction of crop yield from 3 to 13.2 per cent.

2. Plants fertilized in the seed bed with 20 and 25 kilos of ammonia nitrogen per hectare gave yields of 11.8, and 17.2 per cent respectively greater than the unfertilized seedlings.

3. Still better results were obtained when seedlings from the same seed bed were transplanted and fertilized in the field.

4. Burnt lime applied to the seed bed which had been prepared and replanted to rice increased the production of rice by 62.6 per cent and calcium carbonate by 25.8 per cent.

5. In the field, the use of 500 kilos of ground limestone showed no material effect on slightly acid soil.

6. The yield increased progressively with increased amounts of ammonium sulphate applied. It was strongly indicated that the effect of 100 kilos was easily influenced by other factors and not conclusive and that the application of 300 kilos was excessive. The application of 150 kilos per hectare increased the yield by over 20 per cent on the average, and that of 200 kilos by more than 40 per cent.

7. In experiments dealing with single and compound fertilizers, it was found that complete fertilizers generally gave the

highest yield and that nitrogen was the most essential single element (see Tables 12 and 13).

8. Profit was made by the application of complete fertilizer containing small amounts of fertilizing ingredients with Alabang clay soil. A greater percentage of increase was noted with the use of higher rates, but the cost of materials was correspondingly great. Tagudin clay loam proved capable of greater response to fertilizer treatments than Alabang soil.

9. An economical combination of 40 kilos of nitrogen, 30 kilos of phosphoric acid and 20 kilos of potash may be suggested from these results. For soils of low producing power ammonium sulphate alone may prove more beneficial.

10. One application of nitrogenous fertilizer was more favorable than the same fertilizer given in 3 installments.

11. Favorable weather (rainfall) augmented the crop so generally, that the yield from a small application appeared greatly magnified in comparison with the yields obtained by heavy fertilization.

12. Trials were made also of some organic fertilizers. An increase of 61.5 per cent in yield was obtained with cattle dung and lime combined in the second year. With copra cake, the yield was best in the second year after application amounting to 48.9 per cent in the 700 kilos application per hectare. The increase yield tended to fall off in the third year.

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PRELIMINARY STUDY ON PEANUT VARIETIES AT THE LAMAO EXPERIMENT STATION, LAMAO, BATAAN

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SIX PLATES AND THREE TEXT FIGURES

This paper is a continuation of the article on the Peanut Variety Tests at the Lamao Experiment Station, Lamao, Bataan, published in the *Philippine Agricultural Review,* Vol. XVIII, No. 3, for the Third Quarter, 1925, by Mr. Francisco G. Galang, horticulturist, and the present writer, both of the Bureau of Plant Industry. To make the comparison of the varieties under study more comprehensive and complete, the results in the former article are here again presented together with the findings for two more years of the tests. As the object of the experiment was to find out the best yielding varieties or strains of peanuts under the soil and climatic conditions existing at the Lamao Experiment Station, the foregoing data will be sufficient to justify the merits of each individual variety, for the experiment was conducted in the place for four years, with two plantings a year—one in the rainy and the other in the dry season.

CLIMATE AND SOIL

The peanut adapts itself to a wide range of climate and soils, but at the Lamao Experiment Station it is grown only on sandy loam soil, as this is the principal kind there.

As to rainfall, Table I will give an idea of the amount required by the crop, as the data contained in the table were taken during the course of the experiment.

In 1923 the weather was rather favorable for the planting of the rainy-season crop, but while the plants were growing well, heavy rains fell in the months of July, August, and September, which interfered with the culture. The dry-season planting of the same year was carried away by the flood of November 19 and 20, and so another planting was made, which was rather late to catch enough moisture in the soil for the best development of the plants.

TABLE 1.—*Showing the monthly rainfall and the number of rainy days at Lanao during the tests*

Month	1923		1924		1925	
	Rainfall	Rainy days	Rainfall	Rainy days	Rainfall	Rainy days
	Inches	*Number*	*Inches*	*Number*	*Inches*	*Number*
January	0.36	1	1.34	5	....	....
February	2.50	2	0.66	2	1.40	3
March	1.69	4	0.54	2	0.18	1
April	0.88	1	0.61	2	0.17	1
May	20.62	13	4.84	5	5.68	8
June	21.14	21	11.57	16	27.77	20
July	14.91	17	34.84	22	28.36	17
August	54.30	25	30.13	23	39.98	23
September	17.68	19	7.08	10	20.45	19
October	1.20	6	17.05	14	18.09	10
November	18.80	10	6.50	14	1.40	4
December	0.92	5	5.99	8	1.43	3
Total	154.50	124	120.84	123	143.91	109

Month	1926		1927	
	Rainfall	Rainy days	Rainfall	Rainy days
	Inches	*Number*	*Inches*	*Number*
January	0.28	4	0.09	1
February	....	....	....	....
March	0.27	1	0.69	5
April	0.07	1	0.62	5
May	8.00	6	21.55	14
June	24.03	20	8.81	17
July	14.07	17	20.02	19
August	20.50	23	32.91	26
September	15.60	20	12.73	14
October	7.58	11	10.25	15
November	1.55	5	0.83	4
December	2.56	4	1.21	4
Total	94.51	112	119.71	124

Up to the time of maturity of the crop the weather was favorable to the rainy season planting in 1924 although the planting was rather late, as it was not done in May because of the dry spell which prevailed at that time. Not very much rain fell during this season. Weather conditions during the 1924 dry-season planting were excellent.

In 1925 there were many heavy rains during the months of June, July, August, and September, which retarded the growth of the plants at the young stage, and caused the decay and sprouting of the pods at the time the crop was maturing.

The dry-season planting for 1926 suffered drought due to lack of rains from the month of November up to February, and this made the harvesting difficult because the soil hardened. During the rainy season of this year much rain fell, thus causing the poor yields of the culture.

Analyses of the surface soil made by the Bureau of Science, Manila, from where the cultures were conducted, gave the following results:

TABLE 2.—*Showing the mechanical and chemical analyses of the soil*

Composition	Average	Composition	Average
MECHANICAL	*Per cent*	CHEMICAL	*Per cent*
Detritus not passing 1 mm. sieve	3.80	Moisture	6.96
Coarse sand 1–0.5 mm	10.866	Loss on ignition	7.883
Medium sand 0.5–0.25 mm	10.866	Nitrogen (N2)	0.128
Fine sand 0.25–0.1 mm	27.70	Phosphoric anhydride (P_2O_5)	0.236
Very fine sand 0.1–0.05 mm	13.166	Lime (CaO)	1.903
Silt 0.05–.005 mm	30.733	Potash (K_2O)	0.566
Clay .005 mm	14.33	Humus	0.686

MATERIALS AND DESCRIPTIONS

Fourteen varieties and strains of peanuts were tested in this experiment, which may be grouped into two classes; namely, the bunchy and the runner type of plants, producing from large to small size pods.

The *Spanish* is the variety most grown commercially in the Philippines. This was originally imported from Spain. The pods are rather small, usually containing two kernels of a light brown color. The vines grow erect with the pods in clusters close around the base.

The *Tennessee Red* is an introduced variety from the United States. It has a vigorous, erect growth with the pods clustered around the base of the plant. The pods are long and partly twisted, usually containing three or four kernels having a bright red covering.

The *North Carolina Runner* is another variety introduced from the United States. It has a spreading habit of growth, having the pods distributed in all stems touching the ground. The pods are very small and contain two kernels of a light brown color.

The *San Mateo* is native variety similar to the Spanish. It grows erect, having the pods clustered around the base of the plants. The pods are small, usually containing two to three kernels of a light brown color.

The *Vigan Lupog* is another native variety also very similar to the Spanish. The vines grow erect, having the pods in a cluster around the base of the plant. The pods are small containing two to three kernels of a light brown color.

The *San Jose No. 1* is a long podded variety locally grown in San Jose, Nueva Ecija. The vines grow erect very similar to the Tennessee Red. The pods, which are partly twisted, adhere in clusters around the base of the plant. The kernels number three or four with a red covering. With too many kernels the size is reduced.

The *San Jose No. 2,* also from San Jose, Nueva Ecija, has an upright growth; the pods are bunched close around the base of the plant, and are of small size containing two or three kernels of a light brown color.

The *San Jose No. 3,* also from San Jose, Nueva Ecija, is a variety of peanut very similar to the Spanish. The vines grow erect with the pods in bunches close around the base of the plant. The pod contains two or three kernels, but in most cases only two, of a light brown color.

The *Japanese* is a variety introduced from Japan. The pods are very small containing two bright red kernels. The vines grow erect and have the pods in clusters around the base of the plant.

The *Zambales* is a native variety locally grown in Zambales Province. It is a bunchy type with the pods growing in clusters around the base of the plant. The pods are larger than the Japanese with two bright red kernels.

The *Chinese* is a runner type introduced from China. The pods of medium size are distributed along the vines touching the ground in creeping. The kernels are reddish brown in color.

The *Valencia* is another variety originally imported from Spain. The pods are large and contain two kernels having a light red covering. It is a runner and the pods distributed along the vines touch the ground in creeping.

The *Kinorales* is a native variety of the bunchy type, having the pods in clusters around the base of the plant. The pods are very small, similar to those of the Japanese variety and contain two bright red kernels.

The Native is a variety similar to the San Jose No. 1. The vines grow erect and have the pods in bunches around the base of the plant. The pods are long and somewhat twisted containing three or four red kernels.

PLAN OF THE WORK

The land used for the 1923 rainy-season crop had been planted to sugar cane during the two previous years. It is uni-

form and well-drained land with light surface soil. The field occupied by the 1923 dry-season planting was formerly planted to corn and it is somewhat hilly, but the experimental plots were arranged in such a way that there was a fairly equal amount of soil fertility for each of the different varieties of peanuts. This was the only ground available after the flood in 1923, which washed away the first culture (dry-season crop).

The land used for the 1924 rainy- and dry-season plantings was formerly planted to legumes and sorghums. Part of the surface soil of this field was also washed away by the flood when the sorghums were growing there. It is very uniform land, occupied by the 1923 cultures.

The land used for the 1925 rainy-season planting had been previously cropped to sweet potatoes. It has a uniform well-drained sandy loam soil. The dry-season planting occupied a field planted to corn. It is well drained, uniform land with very light surface soil.

The fields used for the 1926 rainy- and dry-season plantings had been planted to corn also. It is uniform, well-drained sandy loam soil.

The preparation of the land preparatory to plantings was the same throughout the tests, that is, the same implements were used and the land not being weedy was plowed twice and harrowed after each plowing. Plantings were done in furrows 80 by 50 centimeters apart, with two seeds to the hill as in corn. Seeds of almost the same age were used for each culture, except for the first culture in the 1923 planting, which was the beginning of the experiment. The seeds planted at this time were not raised in the station, but were of recent introductions and undoubtedly of different ages. This supposition was confirmed by the poor germination of some of the varieties. A guide string was used in order to have uniform spaces between the plants. No irrigation was done. Each culture was cultivated twice with a 5-tooth cultivator to kill the weeds and to loosen the surface soil for aëration, and once with a plow to throw the soil lightly about the base of the plants in order to cover the developing pegs.

The different varieties or strains of peanuts were planted side by side, provided with guard rows and check plots using only one variety throughout the cultures. (See in Figure 1, the plan of setting the experiment.) At maturity of the crop,

harvesting was done by forking the individual hills of each variety taking care not to mix the varieties. After harvesting the pods were washed in the river to remove the adhering soil and to take away the foreign matter, and then dried in the sun before the yield of each variety was taken in kilos for computation. Shelling of the kernels was done by hand.

In calculating the results the method as given by Doctor Mendiola in his "Method of Breeding Tropical Crops" was followed.

RAINY-SEASON PLANTINGS (1923 TO 1928)

In the 1923 rainy-season planting, twelve varieties were tested and the planting was done on June 1, 1923, in a field of 1,710 square meters, from 30 to 360 square meters being apportioned to each individual plot, including the checks. Germination took place six days after planting. The crops were harvested on October 11, 1923.

In the 1924 rainy-season planting, one variety was added to the collection thus making thirteen varieties for the test, occupying an area of 1,203 square meters, allowing 75.20 square meters for each individual plot, including the checks. Planting was done on June 7, 1924, and germination took place five days afterwards. The crops were harvested October 11 to 16, 1924. From the harvests of this season, samples of each variety were obtained for analysis and the results of the analyses as reported by the Bureau of Science are given in Table 4.

One more variety was added, thus making fourteen varieties, for the test in the 1925 rainy-season planting. The culture occupied an area of 2,533.60 square meters, including the five checks, 134.40 square meters, being apportioned for each plot. The planting took place June 16–17, 1925, and the seeds germinated five days after. The crops were harvested October 12–20, 1925.

In the rainy-season planting of 1926 only twelve varieties were subjected to the test, occupying an area of 2,150.40 square meters for each individual plot. Planting was done June 6, 1926, and the nuts germinated June 10, 1926. The crops were harvested October 15–19, 1926.

Table 3 shows the yields obtained during the rainy-season plantings from 1923 to 1926 of the different varieties tested, computed at a 100 per cent stand.

DRY-SEASON PLANTINGS (1923 TO 1926)

In the 1923 dry-season planting, fourteen varieties were cultured in an area of 1,224 square meters of land, or 72 square meters for each plot, including the checks. Planting was done December 7, 1923, and the seeds germinated December 12, 1923. Harvesting took place March 21–22, 1924.

In the 1924 dry-season planting, thirteen varieties were planted in an area of 1,203.20 square meters, or 75.20 square meters for each plot. Planting was done October 23, 1924, and the seeds germinated October 28–30, 1924. The crop was harvested February 27–28, 1925.

In the 1925 dry-season planting, twelve varieties were tested, occupying an area of 2,150.40 square meters of land including the four checks, thus allowing 134.40 square meters for each plot. Planting was done October 26, 1925, and the seeds germinated five days after. Harvesting took place February 8 to 11, 1926.

TABLE 3.—*Showing the computed yield per hectare of peanuts at 100 per cent stand for rainy-season cultures*

P. I. No.	Variety	1923 yield		1924 yield	
		Pods	Kernels	Pods	Kernels
		Kilos	*Kilos*	*Kilos*	*Kilos*
7974	San Mateo	528.33	343.41	882.97	550.00
7975	Japanese	162.50	110.50	308.51	215.96
7976	Spanish	368.88	287.73	671.54	479.81
7977	Kinorales	259.16	178.82	372.34	258.33
7978	Vigan Lupog	1,011.11	697.67	864.36	559.66
7979	Valencia	321.38	189.51	489.36	307.02
7980	San Jose No. 1	460.55	280.94	397.60	255.38
7981	San Jose No. 2	820.27	541.71	634.30	425.43
7982	San Jose No. 3	682.22	416.15	855.05	602.13
8303	North Carolina Runner	591.38	354.83	759.30	503.49
8304	Tennessee Red	699.44	454.64	994.68	627.85
	Chinese	612.50	367.50	706.11	467.59
	Zambales	....	....	768.61	616.73
	Native	....	....	....	....

P. I. No.	Variety	1925 yield		1926 yield	
		Pods	Kernels	Pods	Kernels
		Kilos	*Kilos*	*Kilos*	*Kilos*
7974	San Mateo	709.07	553.08	555.81	433.54
7975	Japanese	587.79	434.96	487.87	384.43
7976	Spanish	1,483.78	1,104.02	564.74	446.15
7977	Kinorales	503.72	408.01	406.28	337.52
7978	Vigan Lupog	752.97	542.14	493.64	379.23
7979	Valencia	537.20	333.06	....	....
7980	San Jose No. 1	1,104.91	778.44	482.07	347.06
7981	San Jose No. 2	1,058.77	804.67	380.29	303.83
7982	San Jose No. 3	889.13	702.41	562.50	450.00
8303	North Carolina Runner	468.01	294.85	344.50	234.27
8304	Tennessee Red	1,011.16	738.15	717.27	537.96
	Chinese	842.26	546.47	....	....
	Zambales	1,024.55	840.13	354.91	287.58
	Native	1,091.52	785.89	515.63	376.41

NOTE.—The average yield of the check plots was 761.27 kilos in pods per hectare.

TABLE 4.—*Showing the oil content*

P. I. No.	Variety	Oil content	
		Sample as submitted	Dry basis
		Per cent	*Per cent*
7974	San Mateo	52.81	56.06
7975	Japanese	56.90	58.80
7976	Spanish	47.59	52.04
7977	Kinorales	50.58	54.88
7978	Vigan Lupog	49.26	53.11
7979	Valencia	44.99	49.08
7980	San Jose No. 1	54.13	58.08
7981	San Jose No. 2	54.10	58.01
7982	San Jose No. 3	49.74	53.14
8303	North Carolina Runner	54.37	56.94
8304	Tennessee Red	56.40	60.07
	Chinese	47.16	51.37
	Zambales	52.61	54.85
	Native	([a])	([a])

[a] Not analyzed.

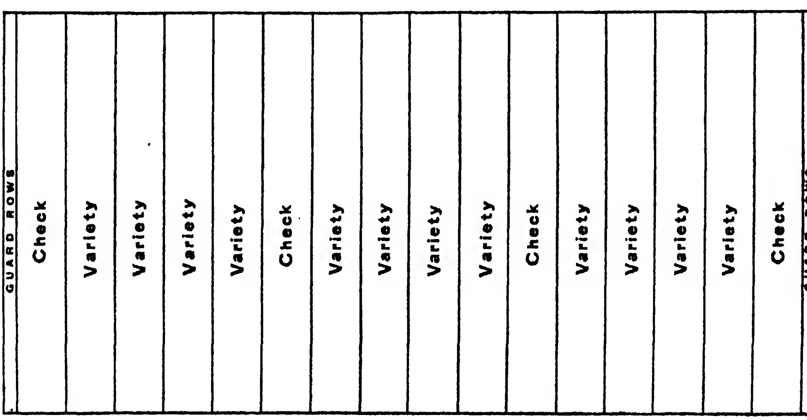

FIG. 1.—A model plan of setting the experiment

In the 1926 dry-season planting again only twelve varieties were tested. Each variety including the checks occupied a plot of 115.20 square meters. Planting took place on November 4, 1926, and germination, five days later. Harvesting was done February 18 to 21, 1927.

Table 5 shows the yields obtained during the dry-season plantings from 1923 to 1926 of the different varieties tested, computed at 100 per cent stand. Table 6 shows the summary of the results given in Tables 3 and 5. Table 7 shows the shelling percentages, number of kernels per ounce and the curing quality of each variety. Figure 2 shows the comparative yields in pods per hectare and the shelling percentages of peanuts for the 4-year tests. Figure 3 shows the comparative yields in kernels

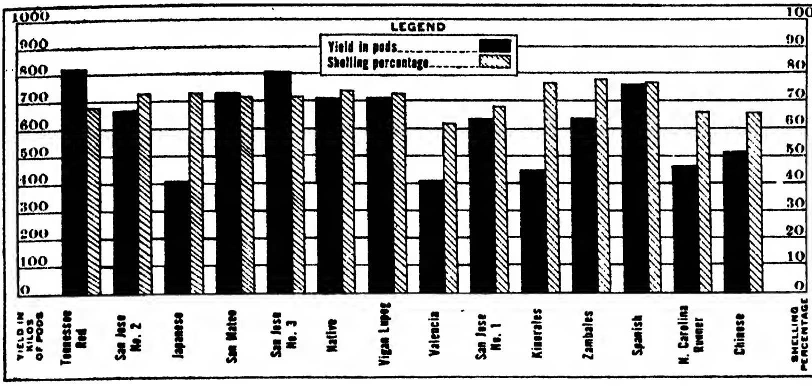

FIG. 2.—Showing the average yields in pods per hectare and the average shelling percentage of peanuts for 4 years tests

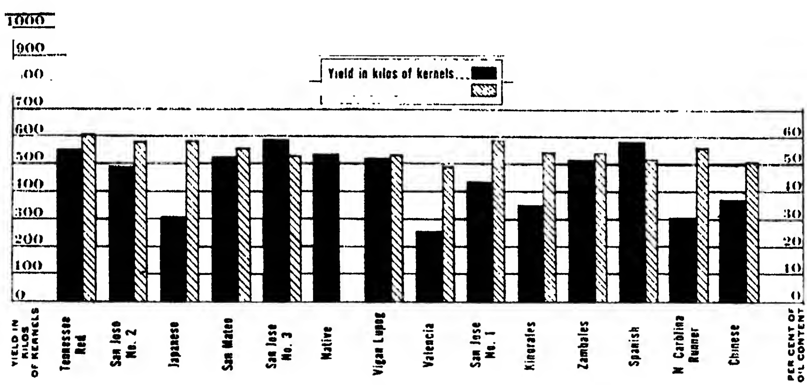

FIG. 3.—Showing the average yields in kernels per hectare of peanuts for 4 years tests with its per cent of oil content

NOTES: No analysis was made for oil content of the Native variety.

per hectare of peanuts for the 4 years' tests and the per cent of oil content.

DISCUSSION OF RESULTS

The seeds of peanuts (kernels being used in this experiment) germinated from four to five days after planting. It was observed during the progress of this work that peanuts suffered from too much rain, their growth being retarded in the young stages of the plants and decay and sprouting of the pods being caused at maturity. A long dry season was also detrimental to peanuts, for the soil turned hard, especially the clay loam soil, checking the proper development of the pods and making it difficult to gather the nuts.

Counting the number of days to mature, it was found that the rainy-season crops of peanuts had an average maturing period of 4 months and 7 days, while the dry-season cultures matured in only 3 months and 20 days.

Only the first culture was attacked by a disease commonly known as leaf spot (*Septoglium acachidis*). The attack was rather severe and made the yields low.

TABLE 5.—*Showing the computed yield per hectare of peanuts at 100 per cent stand for dry season cultures*

P. I. No.	Variety	1923 yield		1924 yield	
		Pods	Kernels	Pods	Kernels
		Kilos	*Kilos*	*Kilos*	*Kilos*
7974	San Mateo	659.72	442.01	873.66	585.35
7975	Japanese	83.33	56.66	627.65	426.80
7976	Spanish	470.83	334.29	579.75	411.64
7977	Kinorales	143.05	107.29	642.20	481.71
7978	Vigan Lupog	666.66	493.33	518.61	383.77
7979	Valencia	384.72	238.53	363.08	225.08
7980	San Jose No. 1	437.50	284.38	904.25	587.76
7981	San Jose No. 2	470.88	324.87	722.27	498.23
7982	San Jose No. 3	670.83	422.62	742.02	467.47
8303	North Carolina Runner	111.11	70.00	534.58	336.79
8304	Tennessee Red	640.27	377.76	856.38	505.26
	Chinese	305.56	216.95	514.62	365.38
	Zambales	494.44	346.11	613.03	429.12
	Native	....	....	....	....

P. I. No.	Variety	1925 yield		1926 yield	
		Pods	Kernels	Pods	Kernels
		Kilos	*Kilos*	*Kilos*	*Kilos*
7974	San Mateo	682.29	545.84	980.64	764.90
7975	Japanese	422.62	321.20	635.07	482.65
7976	Spanish	815.48	644.23	1,199.65	971.72
7977	Kinorales	545.39	441.77	690.10	565.88
7978	Vigan Lupog	576.64	444.02	850.00	588.50
7979	Valencia	....	....	....	....
7980	San Jose No. 1	539.44	382.31	782.20	578.83
7981	San Jose No. 2	540.93	422.33	762.50	617.63
7982	San Jose No. 3	724.71	558.03	1,379.16	1,103.33
8303	North Carolina Runner	363.84	236.50	578.99	440.03
8304	Tennessee Red	597.39	422.07	1,037.50	778.13
	Chinese	....	....	....	....
	Zambales	572.18	461.47	631.85	505.48
	Native	575.89	431.92	690.10	531.38

NOTE.—The average yield of the check plots was 742.11 kilos per hectare in pods.

TABLE 6.—*Showing the average yields of peanuts per hectare at 100 per cent stand for 4 years tests*

P. I. No.	Variety	Rainy season		Dry season		Average for 4 years		
		Pods	Kernels	Pods	Kernels	Pods	Kernels	
		Kilos	*Kilos*	*Kilos*	*Kilos*	*Kilos*	*Kilos*	*Cavans*
7974	San Mateo	669.04	470.76	799.08	584.52	734.06	527.64	11.13
7975	Japanese	386.67	286.46	442.17	321.83	414.42	307.14	6.54
7976	Spanish	767.23	579.38	766.43	590.47	766.83	684.92	12.55
7977	Kinorales	385.37	293.67	505.20	399.16	455.29	346.41	7.45
7978	Vigan Lupog	780.52	544.67	652.98	502.40	716.75	523.53	11.26
7979	Valencia [b]	449.31	276.56	373.87	231.80	411.59	254.18	5.46
7980	San Jose No. 1	611.28	414.20	665.85	458.32	638.57	436.26	9.38
7981	San Jose No. 2	723.41	518.91	624.08	465.51	673.75	492.21	10.58
7982	San Jose No. 3	747.22	542.67	879.18	637.86	813.20	590.26	12.69
8303	North Carolina Runner	540.80	346.86	397.13	270.83	468.97	308.84	6.64
8304	Tennessee Red	855.64	589.65	782.89	525.80	819.27	557.73	11.99
	Chinese	720.29	460.52	410.09	291.17	565.19	375.84	8.08
	Zambales [c]	716.02	581.48	577.87	435.54	646.95	508.51	10.93
	Native [a]	803.57	581.15	632.99	481.65	718.18	531.40	11.42

[a] Only four plantings. [b] Only five plantings. [c] Only seven plantings.

NOTE.—One cavan of kernels equals approximately 46.5 kilos.
The average yield of the check plots is 751.69 kilos per hectare.

TABLE 7.—*Showing the shelling percentages, number of kernels per ounce and the curing quality*

P. I. No.	Variety	Shelling	Number of nuts per ounce	Curing quality
		Per cent		
7974	San Mateo	72	47	Very good.
7975	Japanese	73	58	Do.
7976	Spanish	76	47	Do.
7977	Kinorales	77	59	Do.
7978	Vigan Lupog	73	47	Do.
7979	Valencia	62	41	Fairly good.
7980	San Jose No. 1	68	51	Very good.
7981	San Jose No. 2	73	48	Do.
7982	San Jose No. 3	72	48	Do.
8303	North Carolina Runner	66	60	Good.
8304	Tennessee Red	68	50	Very good.
.	Chinese	66	43	Fairly good.
	Zambales	78	49	Very good.
	Native	74	52	Do.

Rats were the only bad pests. They dug up and ate the pods from young stages up to maturity, leaving none to be harvested.

As shown in Table 6 the four best yielding varieties in pods (calculated at 100 per cent stand) during the rainy-season cultures were the Tennessee Red, the Native, the Vigan Lupog, and the Spanish. The correspoding yields were 855.64, 803.57, 780.52, and 767.23 kilos per hectare, respectively. The other varieties yielded only from 386.67 to 747.22 kilos to the hectare.

In kernels the highest yields were obtained from the Tennessee Red with 589.65 kilos per hectare; Zambales, 581.48 kilos; Native, 581.15 kilos; and Spanish, 579.38 kilos. The rest of the varieties gave only from 276.56 to 544.67 kilos to the hectare.

The highest yielding varieties in pods (calculated at 100 per cent stand) for the dry-season cultures, were the San Jose No. 3, the San Mateo, the Tennessee Red, and the Spanish. The yields were 879.18, 799.08, 782.89, and 766.43 kilos per hectare, respectively. The other varieties yielded only from 373.87 to 665.85 kilos to the hectare. In kernels the San Jose No. 3, the Spanish, the San Mateo, and the Tennessee Red gave a yield of 637.86, 590.47, 584.52, and 525.80 kilos to the hectare, respectively. The other varieties yielded only from 231.80 to 502.40 kilos per hectare.

Summing up the yields obtained from the rainy and the dry-season cultures, the varieties coming out in pods as the highest yielding and those supposed to be best adapted to the soil and climatic conditions at the Lamao Experiment Station, were the Tennessee Red, the San Jose No. 3, and the Spanish giving 819.27, and 813.20, and 766.83 kilos to the hectare, respectively. The rest of the varieties yielded only from 414.42 to 734.06 kilos to the hectare. Considering the yields in kernels, the varieties that came out best from the tests were the San Jose No. 3, the Spanish, and the Tennessee Red. The corresponding yields were 590.26, 584.92, and 557.73 kilos to the hectare. The other varieties yielded only from 254.18 to 531.40 kilos per hectare.

As shown in Table 7 the highest shelling percentages were obtained from the Zambales, the Kinorales, and the Spanish, being 78, 77 and 76 per cent, respectively. Though the Zambales and the Kinorales had very high shelling percentages, yet their yields in kernels were low because of their low yields in pods.

The Valencia peanut was the one having large-sized kernels among the collection with a demand in the market. This variety gave 41 kernels to the ounce. The Chinese variety gave medium-sized kernels with 43 kernels to the ounce. The Spanish, the San Mateo, the Vigan Lupog, the San Jose Nos. 2 and 3, and the Zambales gave fair-sized nuts with from 47 to 49 kernels to the ounce; while the North Carolina, Japanese, and Kinorales gave very small kernels with 58 to 60 kernels

to the ounce. The Tennessee Red, the San Jose No. 1, and the native gave kernels a little larger than those of the Japanese or Kinorales with 50 to 52 kernels to the ounce.

All were of very good curing quality except the Valencia and the Chinese varieties, which because of their thick shell dried slowly, thus sometimes having discolored pods. Very good curing resulted also when the crops were harvested at just the right stage of maturity.

As to the results given by the Bureau of Science, Manila (see Table 4) as per sample submitted, the four varieties which proved rich in oil were the Japanese, the Tennessee Red, the North Carolina Runner, and the San Jose No. 1. They contained 56.90 per cent, 56.40 per cent, 54.37 per cent, and 54.13 per cent, respectively, while the other varieties analyzed only from 44.99 to 54.10 per cent of oil. Analyzing on the dry basis the varieties that came out best were the Tennessee Red giving 60.07 per cent of oil; the Japanese, 58.80 per cent; the San Jose No. 1, 58.07 per cent; and the San Jose No. 2, 58.01 per cent.

The other varieties contained only from 49.08 to 56.94 per cent of oil.

CONCLUSIONS

1. The Tennessee Red was the highest yielding variety in pods during the four years' tests, but considering the yields in kernels the varieties that did best were the San Jose No. 3 and the Spanish giving 590.26 and 584.92 kilos to the hectare, respectively.

2. The Tennessee Red proved the best variety of peanuts for the rainy season planting, giving the highest yield both in pods and kernels, and the San Jose No. 3 for the dry season planting, also being the highest yielder in pods and kernels.

3. The Zambales and Kinorales variety gave the highest shelling percentage.

4. For oil content the Japanese gave the highest per cent as per sample submitted, but on the dry basis the Tennessee Red was first.

5. Peanuts have a longer period of maturity during the rainy season than in the dry season, the difference amounting to 17 days.

6. Too much rain and along dry season are detrimental to the growing of peanuts.

7. The rats were the worse enemies of peanuts, for they dug up the individual plants eating the pods from young stages up to maturity, leaving none to be harvested.

8. The Valencia peanut gave the least kernels to the ounce of all the varieties tested.

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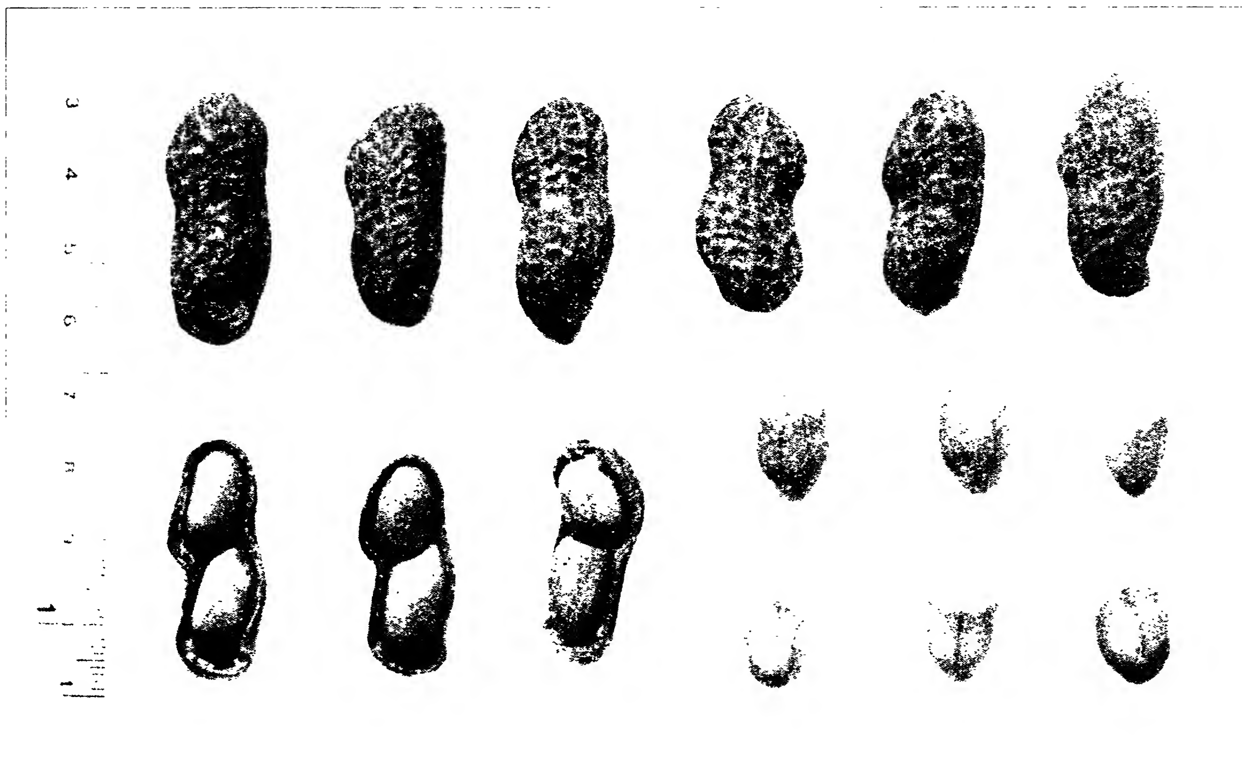

PLATE I. Spanish peanuts

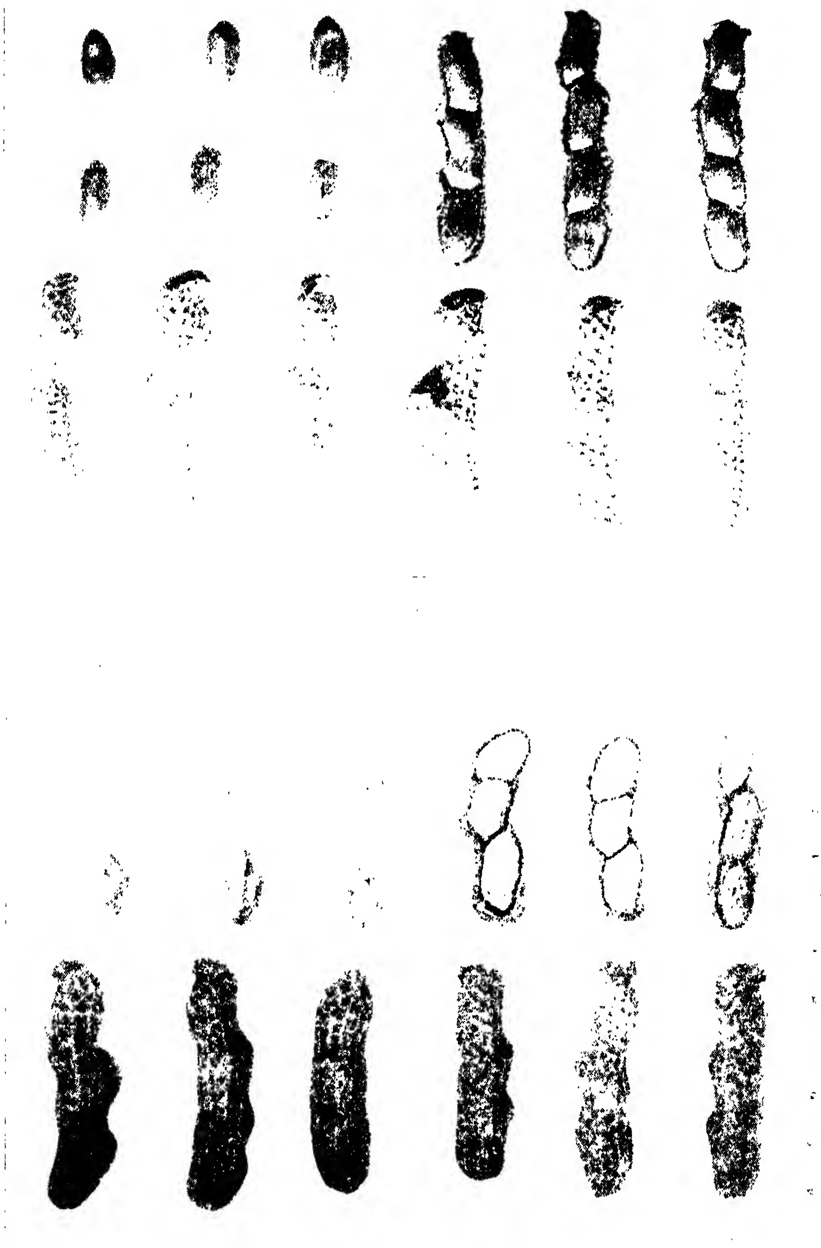

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PLATE II. (1) Tenessee red peanuts and (2) Vigan Lupog peanuts

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2

PLATE III. (1) San Jose No. 1 peanuts and (2) San Jose No. 2 peanuts

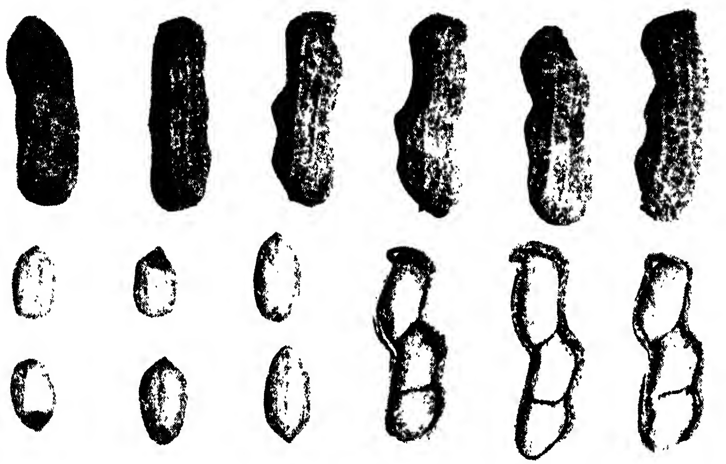

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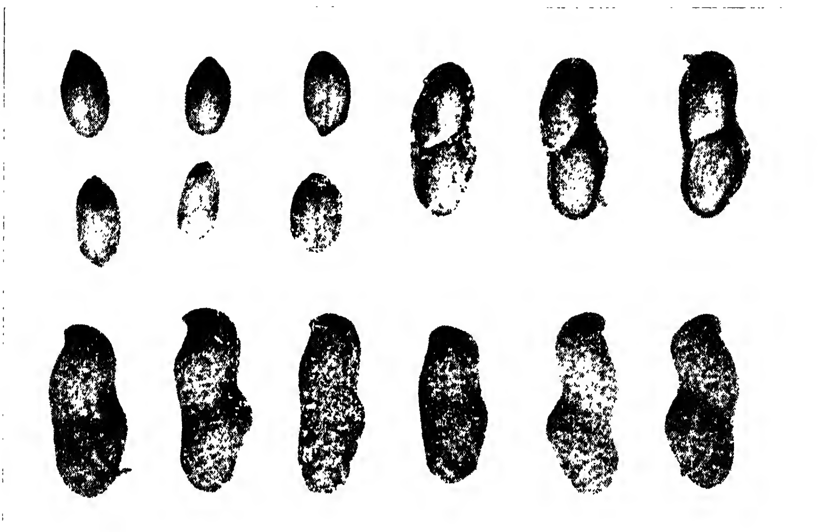
PLATE IV. (1) San Jose No. 3 peanuts and (2) San Mateo peanuts



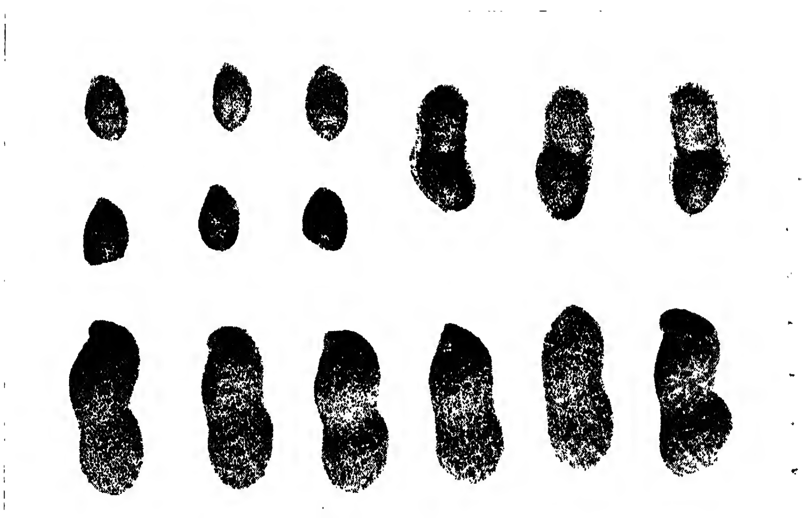


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PLATE V. (1) Chinese peanuts and (2) Japanese peanuts

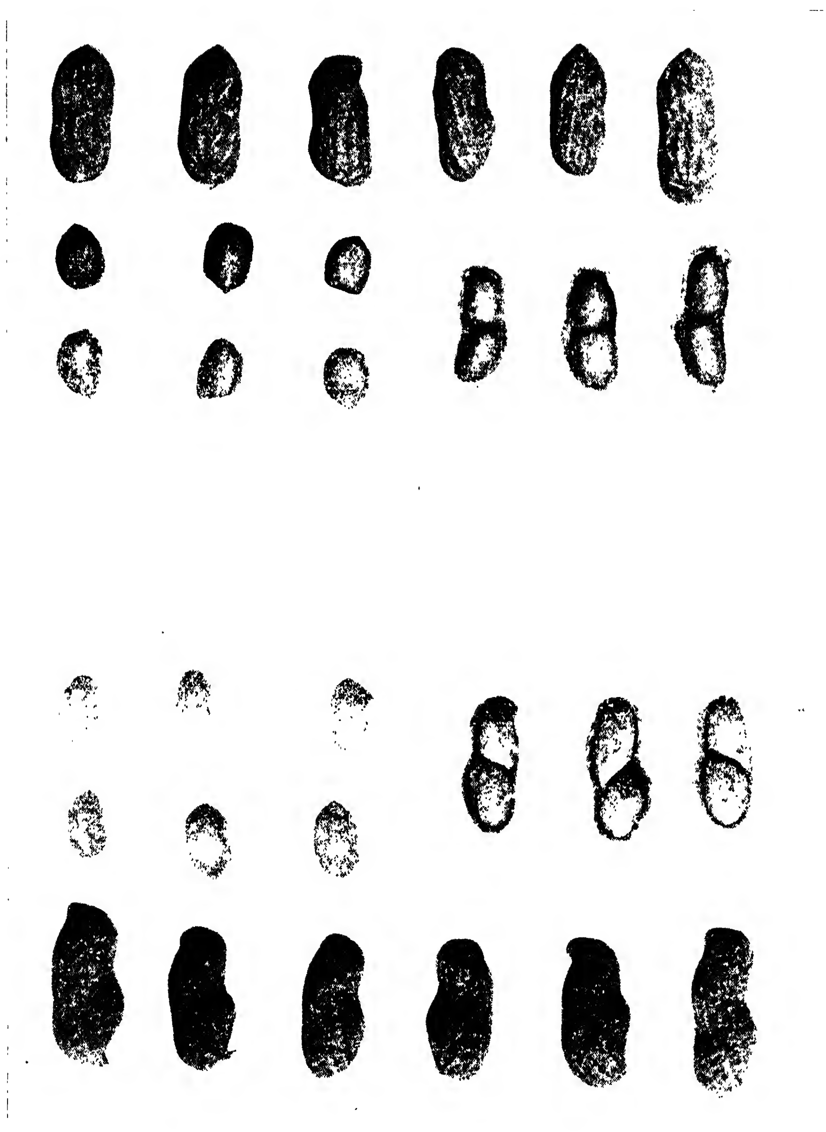

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PLATE VI. (1) Kinorales peanuts and (2) North Carolina Runner peanuts

PROGRESS REPORT ON RICE HYBRIDIZATION AT ALABANG RICE EXPERIMENT STATION

By JUAN P. TORRES
Assistant Plant Breeder

The earliest attempt at crossing rice varieties at Alabang Rice Experiment Station was made by Mr. Victorino Borja, then in charge of the station, during the flowering season of 1920. The following matings of rice varieties were tried: Apostol x Cruz; Cruz x Apostol; Inantipolo x Apostol; and Apostol x Inantipolo. The one with which he succeeded was the Apostol x Cruz. One F_1 plant was produced. With this hybrid it was hoped to produce a strain similar to Cruz in appearance i. e., in color and size of grain with the fairly good table quality and yield of Apostol. In 1923, it was reported that in the F_2 and F_3 generations the Apostol type of grain was dominant over that of Cruz. Plot tests of a number of promising F_3 progenies did not show improvement on yields and so this experiment was stopped.

In the flowering season of 1921 the author produced several seeds from each of the following crosses: Señora II x Cruz, 10 seeds; Ohoy II x Señora II, 7 seeds; Ohoy II x Caviteña I, 2 seeds; Señora II x Tarbayanon, 13 seeds; Shinriki x Apostol, 6 seeds; and Saan a Pinili x Cruz, 2 seeds. Of these crosses only that of Shinriki x Apostol was carried to the second generation. All the F_2 plants resembled the mother plant, Shinriki, and therefore it was concluded that the supposed F_1 plants were nonhybrids. The F_2 seeds of Señora II x Cruz; Señora II x Tarbayanon; and Ohoy II x Señora II, were raised in 1922. In 1923, these F_2 seeds were missing. The seeds from other crosses did not germinate.

After the author's arrival from the United States September 2, 1926, he resumed his rice hybridization work and was able to produce seeds from the following seven crosses: Inadhica x Ramai; Ramai x Inadhica; Inadhica x Macan Baret; Barancal x Inantipolo; Inantipolo x Quinastila IV; Dikit nga Angel x Inadhica; and Nagaho Shinriki x Inadhica. The F_1 seeds were harvested in December, 1926, and January, 1927, and were

placed in germinating agar medium in June, 1927. Having been stored a long while in a half-naked condition, these seeds failed to germinate.

In 1928, it was attempted to make 12 different crosses of rice, Table I, and of this number, seven crosses were performed successfully.

TABLE 1.—*List of 1928 rice crosses*

Cross No.	Crosses	Date emasculated and pollinated	Remarks
28Ah5	S. Vicente x Storm Proof	10-17-28	Not successful.
28Ah6	Storm Proof x S. Vicente	10-17-28	1 hybrid died.
28Ah7	S. Vicente x Apostol	10-15-28	Not successful.
28Ah8	Storm Proof x Apostol	10-15-28	Successful.
28Ah9	Lampadan x Sipot	6-12-28	Do.
28Ah10	Sipot x Lampadan	6-12-28	Not successful.
28Ah11	Baladong x Apostol	10-27-28	Successful.
28Ah12	Ansaket Goyoran x Apostol	10-26-28	Do.
28Ah13	Inagamang x Apostol	10-26-28	Do.
28Ah14	Inadhica x Ramai	12-4-28	Do.
28Ah15	Ramai x Inadhica	12-4-28	Do.
28Ah16	Nalmaon x Inadhica	12-8-28	2 hybrids died.

In 1929 a greater number of crosses were tried and a greater proportion came out successful as shown in Table 2. The objects in making these crosses are given in Table 3.

TABLE 2.—*List of 1929 rice crosses*

Cross No.	Crosses	Date emasculated and pollinated	Number of F_1 hybrids		Remarks
			Seeds	Seedlings	
29Ah1	Apostol x Elon-elon A	12-4-29	1	1	
29Ah2	Apostol x Elon-elon B	12-4-29	2		Seed destroyed by red ants.
29Ah3	Apostol x Guinangang Str. 1	12-24-29	5	2	
29Ah4	Apostol x Macan Biñan	12-13-29	9	9	
29Ah5	Apostol x Macan Santa Rosa	12-10-29	1	1	Died in seedling stage.
29Ah6	Apostol x Macan I	12-4-29	1	1	
29Ah7	Apostol x Ramai	12-4-29			Failure.[a]
29Ah8	Apostol x Uaak	12-6-29	5	5	
29Ah9	Elon-elon x Apostol	12-16-29			Do.
29Ah10	Elon-elon x Inadhica	12-27-29	8	8	
29Ah11	Elon-elon x Macan Santa Rosa	12-10-29			Do.
29Ah12	Elon-elon x Radin Kuning 119	12-9-29	1	1	
29Ah13	Elon-elon x Ramai	12-4-29	5	5	Three made by Mr. B. R. Bautista.
29Ah14	Guinangang x Apostol	12-16-29	3	3	
29Ah15	Inadhica x Khao Bai Sai	11-29-29	1	1	Made by Mr. B. R. Bautista.
29Ah16	Inahica x Radin Kuning 119	12-9-29	4	4	
29Ah17	Inadhica x Ramai	11-30-29			Failure.[a]
29Ah18	Khao Bai Sai x Macan I	12-7-29			Do.
29Ah19	Khao Bai Sai x Macan Santa Rosa	12-10-29			Do.
29Ah20	Khao Bai Sai x Radin Kuning 119.	12-10-29			Failure.[b]
29Ah21	Khao Bai Sai x Ramai	12-7-29	4	4	
29Ah22	Macan I x Ramai	12-7-29	6	6	
29Ah23	Manticanon x Khao Bai Sri	11-21-29	1	1	Made by Mr. B. R. Bautista.
29Ah24	Quinalibo II x Khao Bai Sai	11-27-29	1	1	Do.
29Ah25	Quinalibo II x Ramai	12-6-29	3	1	Do.
29Ah26	Quinalibo II x Sipot	12-3-29	1	1	

[a] Emasculated and pollinated 1 day earlier than date of dehiscence.
[b] Cut to ½ the length of flowering glumes.

TABLE 2.—*List of 1929 rice crosses*—Continued

Cross No.	Crosses	Date emasculated and pollinated	Number of F_1 hybrids		Remarks
			Seeds	Seedings	
29Ah27	Ramai x Apostol	12-16-29	....	....	Failure. [a]
29Ah28	Ramai x Elon-elon A	12- 4-29	12	4	Two made by Mr. B. R. Bautista.
29Ah29	Ramai x Elon-elon B	12- 4-29	....	....	Failure [a].
29Ah30	Ramai x Khao Bai Sai	12- 7-29	24	24	
29Ah31	Ramai x Inadhica	11-30-29	....	....	Do.
29Ah32	Ramai x Macan I	12- 7-29	1	1	
29Ah33	Ramai x Quinalibo II	12- 3-29	5	2	Made by Mr. B. R. Bautista.
29Ah34	Ramai x Radin Kuning 119	12- 9-29	6	5	
29Ah35	Sipot x Tjereh Beunjing	12- 3-29	1	1	Do.
29Ah36	Sipot x Guinangang Str. 1	12- 6-29	5	4	Do.
29Ah37	Inadhica x Elon-elon	12-28-29	4	4	Do.
29Ah38	Elon-elon B x Macan I	12- 4-29	3	3	
29Ah39	Khao Bai Sri x Guinangang Str. 1	12-24-29	4	4	
29Ah40	Inadhica x Sipot	12-23-29	1	1	
29Ah41	Khao Bai Sai x Sipot	12-23-29	5	5	

[a] Emasculated and pollinated 1 day earlier than date of dehiscence.

BREEDING PALAGAD (DRY-SEASON) RICE VARIETIES

From the cross No. A28Ah9, of Lampadan x Sipot the hybrids produced have inherited the bearded character of the Lampadan which, in a palagad crop, should be a desirable character as protection against depredations by birds, especially in places where these are abundant during the dry season. However, our main objective in this cross is to produce a strain in which are combined the high productiveness of Sipot and the good table quality and size or grain of Lampadan.

During the dry season of 1929, about 2,480 F_2 seedlings were raised from six F_1 plants. These seedlings were transplanted February 26, 1929, and were grown to maturity. Out of a large number of matured F_2 generation plants, 78 were selected and set aside for the 1930 palagad planting and these progenies were numbered thus: A28Ah9–1–1 to A28Ah9–1–24, inclusive; A28Ah9–2–1 to A28Ah9–2–30, inclusive; A28Ah9–3–1 to A28Ah9–3–16, inclusive; A28Ah9–9–1 to A28Ah9–9–8, inclusive; and A28Ah9–10–1 to A28Ah9–10–10, inclusive. In this method of numbering the "A" stands for Alabang, the "28" for the year 1928, the "Ah" for artificial hybridization, and the "9" for serial number of the cross. The figure separated by a dash (–) from the accession cross number stands for the hybrid plant or the F_2 progeny number and the figure following the hybrid plant number with another dash separating it represents the F_2 plant number or F_3 progeny number. The above 78 F_3 progenies were planted in February, 1930, and are at present in the field for observation.

The new crosses in which some of the palagad varieties are involved are the following: Cross No. A29Ah3, Apostol x Guinangang Str. 1; Cross No. A29Ah14, Guinangang Str. 1 x Apostol; Cross No. A29Ah26, Quinalibo II x Sipot; Cross No. A29A35, Sipot x Tjereh Beunjing; Cross No. A29Ah36, Sipot x Guinangang Str. 1; Cross No. A29Ah39, Khao Bai Sai x Guinangang Str. 1; Cross No. A29Ah40, Inadhica x Sipot; and Cross No. A29Ah41, Khao Bai Sai x Sipot. The F_1 hybrids of these crosses were put in pots in the glass house to be split into single tillers and then transplanted into the field in July, 1930, for rapid production of F_2 seeds.

BREEDING THE REGULAR-SEASON VARIETIES

Four of the 1928 successful crosses in Table I, are matings of the regular season varieties. These are Cross No. A28Ah12, Ansaket Goyoran x Apostol; Cross No. A28Ah13, Inagamang x Apostol; Cross No. A28Ah14, Inadhica x Ramai; and Cross No. A28Ah15, Ramai x Inadhica. The F_1 hybrids from these crosses have been grown and F_2 seeds raised from them, ready to be planted this season.

The 23 new crosses made in 1929 are shown in Table 2, and like those of the palagad varieties the F_1 hybrid plants were also put in pots in the glass house, to be split and transplanted into the field in order to raise F_2 seeds from them.

STUDY OF STERILITY IN RICE HYBRIDS

There was observed, in 1928, a phenomenal occurrence of sterility in the three natural hybrids of Gopher (numbered A28Nh1 to 3 inclusive, in which "Nh" stands for "natural hybrid") and in the crosses of Storm Proof x Apostol, No. A28Ah8, and Baladong x Apostol, No. A28Ah11. These materials are used for the study of the inheritance of sterility in rice hybrids. The proportion of well-formed grains to empty grains in the panicles of each hybrid plant was determined and most of the good grains were planted to study the behavior of F_2 plants. The segregations of semi-sterile and fertile plants have been recorded. This work is being carried on to the F_3 generation of the Gopher natural hybrid and those of the cross No. A28Ah8, Storm Proof x Apostol. At present writing there are in field culture 4 plants of the fertile type, numbered A28Nh3–1 to A28Nh3–4, inclusive, and 6 plants of the semi-sterile type, numbered A28Nh3–5 to A28Nh3–10, inclusive. From the cross of Storm Proof x Apostol, there are under present culture

in the field, 6 plants of the semi-sterile group, numbered A28Ah8–1–1, A28Ah8–3–1 and A28Ah8–2–1 to 5, inclusive, and 4 plants of the fertile group, numbered A28Ah8–6 to 9, inclusive, and none from the Baladong x Apostol cross.

STUDY OF RESISTANCE OF HYBRIDS TO RICE SCLEROTIA

Among the hybrids that are under test for resistance to *Sclerotia* are the Cross No. A29Ah30, Ramai x Khao Bai Sai; Cross No. A29Ah22, Macan I x Ramai; Cross No. A29Ah10, Elon-elon x Inadhica and Cross No. A29Ah13, Elon-elon x Inadhica and cross No. A29 Ah28, Inadhica x Elon-elon.

This work is being conducted in coöperation with Mr. Gaudencio Reyes, Assistant Plant Pathologist of the Bureau of Science.

TABLE 3.—*Showing the list of different crosses and the principal objects in crossing them*

Cross No.	Kind of cross	Objects in crossing
A28Ah8	Storm Proof x Apostol	To improve the grain type of Apostol and as material for the study of sterility in rice hybrids.
A28Ah9	Lampadan x Sipot	To produce a strain in which are combined the good table quality of Lampadan and productiveness of Sipot.
A28Ah11	Baladong x Apostol	To study the inheritance of sterility in rice hybrids.
A28Ah12	Ansaket,Goyoran x Apostol	To produce a glutinous, early maturing and productive strain for lowland.
A28Ah13	Inagamang x Apostol	To correct the lodging habit of Apostol in fertile soil.
A28Ah14	Inadhica x Ramai	To produce a strain in which are combined the good table quality of Inadhica and productiveness of Ramai.
A28Ah15	Ramai x Inadhica	Same as the preceding cross.
A29Ah1	Apostol x Elon-elon	To combine earliness of Apostol and good trade qualities of Elon-elon and as material for correlation study.
A29Ah3	Apostol x Guinangang Str. 1	To study the adaptability of Apostol to palagad conditions.
A29Ah4	Apostol x Macan Biñan	To study the flowering in rice and its correlation to yields, etc.
A29Ah6	Apostol :. Macan I	To combine the earliness of Apostol and the good table quality of Macan I.
A29Ah8	Apostol x Uaak	Study of inheritance of size of grain in rice and other characters.
A29Ah10	Elon-elon x Inadhica	To combine stiffness of straw of Elon-elon and good table quality of Inadhica.
A29Ah12	Elon-elon x Radin Kuning 119	To study the inheritance of some grain characters and correlation study.
A29Ah14	Guinangang Str. 1 x Apostol	As in Cross No. A29Ah3.
A29Ah15	Inadhica x Khao Bai Sai	Inheritance of flowering period in rice and its correlation to yields and other characters.
A29Ah16	Inadhica x Radin Kuning 119	Inheritance of flowering period in rice and its correlation to yields and other characters.
A29Ah21	Khao Bai Sai x Ramai	Inheritance of flowering period in rice and its correlation to yields, and to combine earliness of Khao Bai Sai and its good table quality with productiveness of Ramai.
A29Ah22	Macan I x Ramai	Same as in Cross No. A29Ah21.
A29Ah23	Manticanon x Khao Bai Sai	Inheritance of flowering period in rice and its correlation to yields, etc., and to combine heavy yield and quality.
A29Ah24	Quinalibo II x Khao Bai Sai	Same as in Cross No. A29Ah23.
A29Ah25	Quinalibo II x Ramai	To combine the good table quality of Quinalibo II with heavy yield of Ramai.
A29Ah26	Quinalibo II x Sipot	Inheritance of flowering period and palagad adaptability.

TABLE 3.—*Showing the list of different crosses and the principal objects in crossing them*—Continued

Cross No.	Kind of cross	Objects in crossing
A29Ah28	Ramai x Elon-elon	To combine the excellent grain quality of Elon-elon and the heavy yield of Ramai.
A29Ah30	Ramai x Khao Bai Sai	Inheritance of flowering period and its correlation to yields, etc., and to combine earliness and quality of Khao Bai Sai with heavy yield of Ramai.
A29Ah32	Ramai x Macan I	Same as in Cross No. A29Ah21.
A29Ah33	Ramai x Quinalibo II	Same as in Cross No. A29Ah25.
A29Ah34	Ramai x Radin Kuning 119	Inheritance of various characters in rice.
A29Ah35	Sipot x Tjereh Beunjing	Inheritance or light articulation in rice.
A29Ah36	Sipot x Guinangang Str. 1	To produce strain with an improved yield.
A29Ah37	Inadhica x Elon-elon	Same as in Cross No. A29Ah10.
A29Ah38	Elon-elon B x Macan I	Inheritance of flowering period and its relation to yield, etc., and to produce a superior, early strain with stiff straw.
A29Ah39	Khao Bai Sai x Guinangang Str. 1.	Inheritance of flowering and of palagad or dry season adaptability character and to produce a strain in which the earliness of Guinangang is combined with good table quality of Khao Bai Saj.
A29Ah40	Inadhica x Sipot	Same as in Cross No. A29Ah39.
A29Ah41	Khao Bai Sai x Sipot	Same as in Cross No. A29Ah39.

ABSTRACTS

DELONG (D. M.), REID (W. J.) & DARLY (M. M.). The Plant as a Factor in the Action of Bordeaux Mixture as an Insecticide. J. Econ. Ent., xxiii, no. 2, pp. 383–390, 2 graphs, 11 refs. Geneva, N. Y., April 1930. Review of Applied Entomology, Vol. XVIII—Ser. A. Part 9, Sept., 1930.

Previous work regarding the use or action of Bordeaux mixture as a fungicide or insecticide is briefly reviewed. In order to become effective, it appears that it must be rendered soluble. It has been suggested that the most important agents rendering copper soluble from a Bordeaux mixture spray film are atmospheric condition, especially moisture. On the other hand, it has been stated that the epidermis of the leaf is to a certain extent permeable to the dissolved substances occurring in the cell sap, and that hence the dew without and the cell sap within cause exmosis to take place, rendering the copper hydroxide at least partly soluble. An account is given of experiments carried out to test these statements.

Tests with inverted petri dishes covered with capping membranes (R.A.E., A, xvi, 318) and containing sugar solutions or expressed plant juices showed that copper could be dissolved from Bordeaux mixture residues sprayed on the capping membranes. Distilled water used in the same manner gave negative results. Rain-water, collected over a period of approximately 3 months, that had passed through glass funnels containing filter papers covered with Bordeaux mixture gave negative chemical tests for copper. Soluble copper was, however, very readily detected in rain-water collected from plants that were previously sprayed with Bordeaux mixture, and in distilled or tap water in which sprayed leaves had been washed. Leaf-hoppers will die in a short time upon plants that have been sprayed with Bordeaux mixture although protected from rain and dew, some factor other than precipitation rendering the copper soluble.

Refractometer readings of the juices of sprayed and unsprayed plants showed that, in the case of plants of vigorous growth, the solid (sugar) content of the sprayed plants was generally lowered for about two days below that of the unsprayed plants, but soon rose, and with few exceptions remained higher than that of the unsprayed plants for about two weeks.

GILBERT, S. M.: Extension Work (in Trinidad). Tropical Agriculture, Vol. VII, No. 10, October, 1930.

If a bird's eye view of the position in regard to peasant agriculture is taken, four main factors at once stand out—

(*a*) The illiteracy of the majority.

(*b*) Their state of indebtedness to money lenders.

(*c*) The retarding effect of the system of land tenure when considered in connection with development.

(*d*) The difficulties that arise owing to local customs.

Only the passage of time and a sound educational policy can remove these difficulties. For these reasons new methods must be simple, cheap, give an adequate return over old methods or save labor and do not conflict with local laws, customs or religion.

Some of the methods enumerated are: Nonofficial associations; agricultural societies; coöperative credit and agricultural societies; seed farms; and propaganda.

HILGENDORFF (G.). Uebe die Normung des Scheweinfurtergruns fur den Pflanzenschutz. (On a comparative Standard for Paris Green for Plant Protection.) Nachr. Bl. deuts. PflschDienst, x. no. 4, pp. 28–29. Berlin, April, 1930. The Review of Applied Entomology, Vol. XVIII—Ser. A. Part 9, Sept., 1930.

The standard of quality suggested for Paris Green (R.A.E., A, XV, 112) has been found to require modification. The conditions that the German Plant Protection Service now require to be satisfied are as follows: The fineness as tested in the sulphurimeter must not be under 25° Chancel. Water-soluble arsenite compounds present must not exceed 3.5 per cent of arsenious oxide (As_2O_3). At least 95 per cent of the precipitate deposited in water must pass a "6,400" sieve (one with a mesh width of 0.075 mm. and a wire thickness of 0.050 mm.). The residue left in the sieve must not contain particles and impurities likely to choke the sprayers. The arsenious oxide content must be at least 55 per cent, that of oxide of copper (CuO) at least 30 per cent and of acetic acid at least 10 per cent. There must not be more than 1 per cent of water. The methods to be followed in making analysis are described.

JOUBERT, M. J.: Preventing and Combating Soil Erosion. Farming in in South Africa, Vol. V, No. 54, September, 1930.

To prevent and combat soil erosion, the farmer should thus bear in mind the following points:

(1) A sensible system of grazing.

(2) The natural vegetation should be given opportunity to propagate.

(3) The first step in preventing erosion is to spread out the run off at the highest points on the farm.

(4) To control storm water, its destructive force should be broken by spreading it out, which is just as important as the damming of the sloot.

(5) Dams and barricades are damaged by practically every rain, and it is necessary, therefore, that breakages be regularly repaired.

(6) Preventing and combating erosion costs money, and the farmer should, therefore, not only protect the silt by planting it with certain trees and plants, but he should also plant such kinds as will provide stockfeed, and compensate him in a measure for the outlay.

(7) The farmer who starts to combat soil erosion should remember that it is not an evil that can be disposed of in a day. As long as civilization exists will erosion continue, and a campaign against it should, therefore, be persistent and merciless, like the evil itself. Every farmer should fight erosion tooth and nail as long as he remains the owner of his farm, and he should make a beginning forthwith and persists in his efforts, as then only will he accomplish something, not only for himself but also for posterity.

KLOTZ, L. J. and FAUCETT, H. S.: The Relative Resistance of Varieties and Species of Citrus to Pythiacystis Gummosis and other Bark Diseases. Journal of Agricultural Research, Vol. 41, No. 5, September 1, 1930.

A review of the literature is given, summarizing the range of susceptibility or resistance of the various species and varieties of Citrus and Citrus relatives to canker, West Indian lime anthracnose, withertip disease, scab, psorosis, decorticosis, and Pythiacystis gumosis.

The inoculation tests show that dependable comparisons of the response of species and varieties of Citrus to Phythiacystis gummosis can be made only on trees which are all of the same age and which are under similar environmental conditions.

Great variations in degree of susceptibility were shown by different varieties of the same species, individuals of the same variety, and even by two or more locations on the same tree trunk, necessitating several inoculations on each tree to obtain a dependable average.

The varieties of the pummelo and citrange groups showed the largest differences in response to the disease, ranging from a susceptibility exceeding that in the lemon varieties to a resistance greater than the average of the sour orange group.

Under the conditions of the tests reported here the varieties of the individual groups as a whole rank in descending order of susceptibility as follows: Lemon, citrange, lime, pummelo and sweet orange, mandarin, rough lemon, tangelo, sour orange, and kumquat.

The amount of gum formed is approximately proportional to the severity and extent of the disease.

Calamondin (*Citrus mitis*), *C. hystrix*, *C. limetta*, *C. ichangensis*, Sampson tangelo, and the Cunningham, Sanford, and Savage varieties of citrange exhibited sufficient resistance to justify their trial as possible rootstocks.

The great variability found and the difficulties experienced in obtaining uniform trees and conditions for field tests suggest the desirability of dependable biochemical tests for resistance. Determination of the degree of inhibition of fungal enzymes by substances in the bark of the several hosts may be practical laboratory procedure. Preliminary results of such biochemical tests and a comparison with field results are given.

LEEFMANS (S.) & VAN DER VECHT (J.). De rood-geringde mangga-rups. (The red-ringed Mango Caterpillar.) Korte Meded Inst. PlZiekt., no. 14, 6 pp. 2 pls. Buitenzorg, 1930. (With a Summary in English.) The Review of Applied Entomology, Vol. XVIII—Ser. A. Part 9, Sept., 1930.

Since 1922, mango fruits have been found to be damaged by the larva of the Pyralid, *Noorda albizonalis*, Hmps., in various parts of Java. The caterpillars, which are described, pupate in the ground in a silk-lined earthen cocoon. A brief description of the adult is given. Mangos of varying size are attacked, as many as eleven individuals being found in one fruit. Development appears to take about five weeks, the larval and pupal stages occupying about a fortnight each. Feeding occurs first on the pulp and then on the seed, which is destroyed. *Mangifera odorata* and some varieties of *M. indica* are attacked. Several insects, including the

mango fruit-fly, *Dacus ferrugineus*, F., enter by the lesions caused by *N. albizonalis*. It is not known how this Pyralid survives between two mango harvests. No parasites were bred.

POPE, FELIX T.: Rubber Seed Cake as a Feedstuff. India Rubber World, October 1, 1930.

Rubber seed when crushed produces about 44 per cent of oil, 50 per cent cake or meal, and there is approximately 6 per cent shrinkage. The oil is said to be used as an edible oil, and in making soap, linoleum, and paint, and has practically the same analysis as soybean oil.

The Virginia Polytechnic Institute, in conjunction with Virginia Agricultural Experiment Station, has recently issued a bulletin on Feeding Hevea Rubber Seed Meal for Milk Production. This bullentin states that Hevea rubber seed meal is a new high protein cattle feeding concentrate in the United States, having a pleasant odor something like coconut meal. They give the following analysis of recent samples of the meal:

	Per cent
Moisture	5.0– 6.0
Oil	4.4– 6.0
Protein	30.0–33.8
Carbohydrates	40.0–44.0
Crude fiber	7.2–12.0
Ash	5.6– 6.0

ROXAS, MANUEL L. and VILLANO, MANUEL: Studies of the Development of Sugar-Cane Plant in the Philippines. The Philippine Journal of Science, Vol. 43, No. 3, pp. 367–401, 5 pls. 11 figs. November, 1930.

Root studies in other countries.—In the preparation of this paper the excellent publications of Weaver and his co-workers and the work of Walters and of Venkatraman and Thomas were consulted for the purpose of comparing results.

Object of the present work.—The root system of cane has been studied principally from its vertical distribution. As a result of these studies great significance has been attached to the discovery that 70 per cent of the root mass is in the topmost eight inches of soil.

A complete picture of the root habit of the cane plant can not be given by distribution studies in one direction only. Therefore studies in two directions seem desirable.

There seems to be some contradictory evidence as to the absolute correlation between shoot and root weights, as affected by fertilizers, and it was thought that parallel determination of these weights, taken during the early development of the cane plant, both fertilized and unfertilized, would give more conclusive proof of such a dependence.

Methods and materials used in these studies—The modified box experiments.—On a hillock with a rather abrupt slope, holes 78 and 72 centimeters were dug to a depth of 36 inches. Each 6-inch layer of soil was dug out separately from the other layers. A hillock was selected for the box experiments in order that the washing of the roots at the time of the excavation could be done more easily. Each hole was fitted at the

four corners with wooden posts, 8 by 3 by 100 centimeters. To three posts were nailed the five frames holding the wire netting. The holes were filled with soil as follows: First the lowest shelf of wire netting was placed in position and nailed to the posts. Then the corresponding subsoil layer was placed on top of the shelf, packed down, and watered to make the soil set to its original condition. Subsoil was thus put on until the level of the next higher shelf was reached. This second shelf was then put on and similarly nailed to the posts. The corresponding layer of subsoil was again replaced, compacted as in the first layer, and the process was thus continued, layer by layer, until the last shelf and the topmost soil layer were replaced. Finally, water was allowed to precolate through all the layers to make the soil as compact as it was before digging. A well-selected point of Mauritius 1900 was planted in the topmost layer of the box. The soil around the growing cane was hoed as often as necessary.

Excavation of the roots.—A deep ditch was made at the lowest end of the row of boxes, for the reception of the water and the washed soil from the boxes. As the sides of the holes were left open, it was expected that the roots of the cane extended beyond the wire shelves. Therefore, in starting the excavations, ditches were dug on the sides of the original holes first and any root masses found were collected separately for every 6-inch layer and later placed together with the roots from the corresponding layers in the wire netting. After ditches were dug around the frames, the roots were washed off and the whole frameworks with their load of roots and cane shoots removed and photographed. Then the roots were cut, beginning from the lowest and proceeding to the topmost layer, put together with the corresponding layer collectetd from the sides, and stored for drying and weighing in the laboratory.

The field experiment.—The field experiment was located on level ground some 200 meters from the box experiment described above. The type of soil in the two was the same; light clay derived from volcanic tuff. However, the lot for the field experiment had richer soil.

The field was 50 by 15 meters and divided into lots 5 by 5 meters. There were thirty lots in all, arranged in six groups of five. Three alternating groups received fertilizers. The remaining three served as controls. Twenty-five well-selected points of Mauritius 1900 were planted in each plot, one at each corner of the 1 by 1-meter square. Such a spacing, locally called *dama-dama,* was necessary to reduce to the minimum the competition between roots of adjacent stools. The fertilizer was applied by mixing it with soil deep below the point at the time of planting.

Excavation of the roots.—In each section a group of four stools in the middle of each plot was selected. Each stool was excavated separately. In all, twelve stools for the fertilized and the same number for the unfertilized were dug out each month. The method of digging was by sectioning in two directions, horizontally and vertically. The vertical sections were at intervals of 6 inches and are indicated from top to bottom by subscript numbers 0, 1, 2, 3, etc. The horizontal ones were at intervals of 12.5 centimeters, or 4.92 inches, and are designated from inside out by the letters A, B, C, and D. Thus: A, B, C, and D are the sections in

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the first horizon, or the "0–6;" A_1, B_1, C_1, and D_1; those in the second or "6–12" horizon, etc. As in the Hawaiian method, the soil dug out was thrown unto a wire screen held in a wooden frame. The roots were collected, placed in bags, properly labeled, and taken to the laboratory for drying and weighing.

Results.—In both studies it was found that increased shoot development corresponded to increased root development, without exception.

The roots of the cane develop faster than the shoot during the first months of its growth. This is in line with the old conception that plants first develop a good root system before shoot development will take place actively.

Aëration of the subsoil favors the formation of greater masses of roots in the lower levels.

The cane plant tends to concentrate its mass of roots within a zone about 5 inches on each side and 12 to 18 inches below the foot of the cane. This is the zone where fertilizer must be applied.

Fertilizer increased the masses of roots through the whole system and not only in the zone where the fertilizer was applied.

The suggested method of application is to place the fertilizer in the furrow just before planting in a oval of about 6 inches, mixing it thoroughly with the soil and pouring water over it to carry it down to the lower levels. The point should be planted over this oval.

Further studies, using the method followed in this paper and including other varieties and the whole period of growth of the cane plant, are recommended.

SCHWARDT (H. H.). Borax as an Insecticide for Protecting Seed. J. Econ. Ent., xxiii, no. 2, pp. 401–404, 7 refs. Geneva, N. Y., April, 1930. The Review of Applied Entomology, Vol. XVIII—Ser. A. Part 9, Sept., 1930.

In experiments against *Calandra* (*Sitophilus*) *oryzae*, L. (Rice weevil) in stored maize, powdered borax was applied to the grain at the rate of 10 oz. to the bushel. Examination after 4–7 months of treated and untreated cans, all of which had been supplied with 25 adults of *C. oryzae* showed that whereas the untreated cans contained large numbers of live and dead weevils and the grain was ruined, the treated ones contained only a small number of dead weevils and the grain was in perfect condition. Germination tests showed that the viability of the grain was unimpaired. *Bruchus quadrimaculatus*, F., was similarly controlled by the application of 20 oz. borax to a bushel of cowpeas. On 1,000 treated cowpeas only 125 eggs were found, whereas a similar number of untreated peas contained 4,868 eggs and only two peas were uninfested. The fact that very few feeding punctures were found on treated maize suggests that borax either acts by contact or is repellent to the extent that weevils starve rather than feed on it. Borax is not poisonous to animals, but is apparently detrimental if fed for a period of time, so that treated grain cannot at present be recommended as food for livestock. Planting maize treated at the rate of 10 oz. to the bushel adds less than 2 oz. of borax per acre to the soil, which is a negligible amount.

TANAKA, TYOZABURO: On the Origin of Citrus Species. Studia Citrologica, Vol. IV, No. 1, September, 1930. (Tanaka Citrus Experiment Station, Mino-mura, Fukuoka-Ken, Japan)

Previous papers of the author had given the proof that Citrus and Citrus relatives were descended through the chain designated as *Clausema—Hesperethusa—Citropsis* (*Poncirus*)—*Citrus* (*Fortunella*). Further investigations show that the genus Citrus can logically be classified into two subgenera, 7 sections and 3 subsections given as below:

Subgen. 1. ARCHICITRUS, Tanaka.

Sect. 1. PAPEDA (Hassk.) Tanaka, including *Citrus hystrix, C. macroptera* & C. *latipes.*

Sect. 2. LIMONELLUS (Rumph.) Tanaka, including *Citrus aurantifolia.*

Sect. 3. CITROPHORUM (Necker) Tanaka, including *Citrus medica, C. limon, C. limonia* & C.

Sect. 4. CEPHALOCITRUS Tanaka, including *Citrus grandis C. paradisi, C. intermedia* & C.

Sect. 5. AURANTIUM (Tourn.) Tanaka, including *Citrus aurantium, C. sinensis, C. medioglobosa* & C.

Subgen. 2. METACITRUS, Tanaka.

Sect. 1. OSMOCITRUS Tanaka, including *Citrus junos* and *C. ichangensis.*

Sect. 2. ACRUMEN (Gallesio) Tanaka.

Subsec. 1. EUACRUMEN, Tanaka, including *Citrus nobilis C. unshiu* & *C. yatsushiro.*

Subsec. 2. MICROACRUMEN, Tanaka, including *Citrus deliciosa, C. poonensis, C. tangerina, C. erythosa, C. kinokuni, C. leiocarpa, C. tachibana, C. depressa* & C.

Subsec. 3. PSEUDOFORTUNELLA, Tanaka, including *Citrus microcarpa.*

Morphological evidences which lead this conclusion are summarized in the article.

WET, J. D.: How the Extension Officers Assist Farmers. Farming in South Africa, Vol. 5, No. 53, August, 1930.

What is extension work? To say that it is rural education may give the idea that, like the university system, it rests on classroom work, texts and lessons and the intention to impart a system or mass of knowledge. That sort of teaching, however is left in the college classroom. Extension work is more than a system of disseminating agricultural facts or giving expert advice. The first principle of extension teaching is to work a local situation with the problems as farmers find them. An extension officer is required to find the important things which affect farming and country life in an area. Then with the help of the leading farmers he must try to influence a majority of the people in the locality to understand the solutions of farm problems and to adopt them as regular practices in place of the old methods of doing things. Extension work is concerned in teaching better practices. Its teachers depend less upon text, lecture in classroom and more upon the force of practical examples and local

leadership. As they live with the farmers themselves, the extension workers can therefore study the needs of farming and rural welfare in their respective areas. The extension worker is in full sympathy with the needs and desires of the farmers. He assists and advises them accordingly. This is far more effective than the older methods of sending an occasional speaker of using educational materials prepared outside of the area. Extension officers are technically trained for their work, but above all they must have practical experience and be practical minded. One of the most important features of the extension work is the local demonstrations carried out on farms to show local farmers how the recommended practices compare with those usually followed. Thus the recommendations are tried out under the actual field conditions prevailing in the locality. The results can be seen and compared with present methods by everyone and the public is invited to see these demonstrations. Comparisons can be made, conclusions drawn and the application for the individual made clear. In this way theory is reduced to practice and this practice is exemplified in the area under the conditions presented there. This is the acid test and for the practical farmer it is the most convincing proof of the worth of the practice recommended.

WILLARD, H. F. and BISSELL, T. L.: Parasitism of the Mediterranean Fruit Fly in Hawaii. Circular No. 109, U. S. Department of Agriculture, March, 1930.

The Mediterranean fruit fly, since it was discovered in Hawaii in 1910, has been a major fruit pest in all parts of the Territory. Of the various methods employed in different parts of the world to control this pest, the use of introduced parasites is the only one which has been found adapted to the peculiar horticultural conditions of Hawaii. In 1913 and 1914 three braconids, *Opius humilis*, *Diachasma tryoni*, and *Diachasma fullawayi*, and one chalcid, *Tetrastichus giffardianus*, were introduced and established by the Territorial government. This circular records the effectiveness of these parasites during the 3-year period 1922 to 1924, inclusive, and is a continuation of similar records made since 1914.

The infestation of fruits by the fly during the three years under consideration was less in the majority of hosts than the average infestation per fruit over the 9-year period 1916 to 1924, inclusive. The decrease in infestation of host fruits indicates a decrease in the abundance of adult flies.

Parasitism by *Opius humilis* reached its minimum, 4.1 per cent, in 1923, owing probably to the effect upon it of the two species of Diachasma. In 1924, the parasitism (14.5 per cent) by this species was greater than for any year since 1916. Owing to the hibernation habits of *D. tryoni* during the cooler months of the year the effectiveness of this parasite decreases during those months and at the same time there is a corresponding increase in effectiveness by *O. humilis*.

The work of these four parasites during the three years under consideration has not varied to any great extent from that of the preceding six years. They continued to parasitize nearly 50 per cent of the larvae about Honolulu, causing a corresponding decrease in infestation of the commercial hosts.

The Philippine Journal of Agriculture

[Formerly THE PHILIPPINE AGRICULTURAL REVIEW]

VOL. I FOURTH QUARTER, 1930 No. 4

THE FRESH BEEF SUPPLY OF THE PHILIPPINE ISLANDS

By STANTON YOUNGBERG, D.V.M.
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TWO PLATES AND ONE TEXT FIGURE

There are no records to show that beef cattle are indigenous to the Philippine Islands nor that there were any extensive introductions during pre-Spanish times. Antonio de Morga, who came out to the Philippines in 1595 as Lieutenant Governor-General and stayed here till 1603, gives us the first reliable account of conditions in this country during that period in his "Sucesos de las Islas Filipinas." He says that up to 1575 or during the first ten years of their occupation, the Spaniards got along with what they could get locally, and the articles of food mentioned were rice, carabao meat, deer meat, pork, lard, chickens, eggs, coconut, and *tuba*. It would therefore appear that there were at that time very few, if any, cattle in the Islands. He states that the first horse was introduced into the Islands from China in 1574 by Captain Juan Pacheco Maldonado. No dates are given with reference to the importation of cattle. Speaking of Cagayan Province, he refers to two kinds of cattle: those from China and those from New Spain (Mexico); and one would therefore infer that the progenitors of the bovine population in these Islands were first introduced from those two countries.

No reliable statistics are available as to the number of cattle in the Islands during the first three centuries of Spanish occupation. The first statistics obtainable were published in 1891 and showed a total of 402,630 head of cattle. Undoubtedly, the cattle population must have been considerably larger a few

years before that time. Rinderpest was introduced into the Islands about the year 1886 and we know that it caused tremendous losses. It has been stated that in many places the death rate from this disease was as high as 90 per cent. It appears that by 1894 the disease had largely run its course, leaving only a fraction of the herds it had attacked. The remaining animals were immune to the disease and bred rapidly and the Islands were beginning to restock themselves. It appears that in spite of the high mortality at that time but few cattle were imported. Then came the Insurrection of 1896, followed by the Spanish-American War and the troublous years at the beginning of the 20th century. Those were years in which rinderpest again caused heavy losses. It is said that during that period many provinces lost from 50 to 60 per cent of their cattle and carabaos. The census of 1903 reports that 629,176 cattle and carabaos died of the disease in 1901 and 1902. That census also shows only a total of 127,559 head of cattle in all the Islands. From that day up to the present, with better organization and improved facilities for the control of dangerous and communicable animal diseases, there has been a steady increase in the number of cattle until the total at the end of 1928 was 1,107,794.

The comparatively greater number of cattle in the Islands before the advent of rinderpest shows that in the absence of contagious diseases, conditions for the raising of cattle are quite favorable. This very fact is in a great measure responsible for the relatively small increase that has taken place during the past thirty years. Before rinderpest made its appearance, cattle did so well and increased so rapidly that it caused the people to neglect their herds, in some cases even to the point of letting them "run wild." Upon the arrival of contagious diseases, this habit had become so fixed that practically nothing was done by them to protect their animals. Those who had a few animals left still continued neglecting them. Others who might have been able to acquire herds of cattle very rarely did so, since they thought that disease was inevitable and that protective efforts were not of much value. Therefore the fear of contagious diseases has been sufficient to cause the people to shun the investment of money in cattle-raising enterprises.

The two types or breeds of cattle mentioned by De Morga are distinguishable in the Islands to this very day. The cattle

of Mexican origin are represented by the black or black and white cattle of the islands north of Luzon. Those of Chinese origin are more widely distributed than those from Mexican stock. Among those of Chinese origin are cattle of two types which can be referred to respectively as Batangas and Ilocos. The Batangas cattle are blocky and compact with a symmetrical body placed on short, well-fitted legs. They are very docile and make splendid draft animals. The Ilocos type is more upstanding and lankier and is used very extensively for road work.

In 1909, the Bureau of Agriculture introduced 12 head of Nellore cattle from India and since that date other introductions have been made both by the Government and private individuals. In some parts of the Islands, they have been used extensively for crossing on native cattle in order to produce a larger and heavier animal. Indian cattle and their crosses are found in larger numbers on the Island of Mindanao than anywhere else in the Archipelago. One of the principal reasons for their introduction was the fact that they are highly resistant to rinderpest, which until very recently was the most serious problem confronting agriculture in this country.

The people of the Philippine Islands are not heavy beef-eaters, especially when compared with such countries as the Argentine, Australia, Canada, United States, and the British Isles where the per capita consumption per annum is respectively, 76, 72, 33, 30, and 29 kilos. For the Philippine Islands, the per capita consumption is only 1.46 kilos, but excluding the consumption in the City of Manila, this is reduced to the very small figure of .85 kilo. During the year 1929, Manila consumed 1,859,729 kilos of fresh beef furnished by 16,840 local cattle, 1,732,453 kilos of fresh beef from 9,016 imported cattle, and 3,636,803 kilos of imported frozen beef, or a total beef consumption of 7,228,985 kilos. The per capita beef consumption of Manila alone for that year was therefore 23.2 kilos. The great difference between the beef consumption of Manila and the rest of the Islands is due to many causes. Among the most important ones may be mentioned the fact that it is a very cosmopolitan city, the capital and chief port of the Islands toward which all commodities naturally gravitate. The laboring class of the city receives a higher wage than the strictly agricultural labor of the provinces. More is expected of it and it is therefore in a position to consider beef as a fre-

quent component of the diet instead of a luxury, as is the case in many provinces.

The greatest provincial consumption is recorded in the Batanes Islands, where the per capita has reached 5.64 kilos and the lowest is for Cotabato, where it has been only 0.10 kilo. Cebu, the second port of the Islands, has a per capita consumption of 0.94 kilo, while that of Iloilo, the chief port of the sugar region is 1.72 kilos. The great consumption in the Batanes can be accounted for by the fact that they are wind-swept islands lying in the channel between Luzon and Formosa, the principal industry of which is cattle-raising and where, on account of local conditions, fishing is a difficult proposition.

The ten provinces of Masbate, Batangas, Bukidnon, Ilocos Sur, Cotabato, Zamboanga, Sulu, Mindoro, Palawan, and Romblon furnished 90 per cent—1,679,243 kilos—of the native beef consumed in Manila during the year 1929. A total of 14,916 head was slaughtered to supply that amount. The total cattle population of these ten provinces in 1928 was 343,522 or 31 per cent of the total number of cattle in the Islands. In other words, 4.3 per cent of the number of cattle in these provinces were sent to Manila market for slaughter, a number that is smaller, however, than their annual increase. The cattle furnished by the remaining provinces for the Manila market constituted an insignificant part of their total number.

The following table shows the number of cattle imported into the Philippine Islands each year from 1900 to 1929:

1900	4,555	1915	17,027
1901	2,266	1916	7,726
1902	15,435	1917	5,289
1903	29,783	1918	1,880
1904	35,828	1919	9,595
1905	30,256	1920	10,422
1906	30,729	1921	34,927
1907	38,300	1922	24,180
1908	42,567	1923	11,863
1909	39,161	1924	8,995
1910	60,789	1925	10,959
1911	25,932	1926	9,025
1912	20,735	1927	11,108
1913	7,542	1928	8,640
1914	11,089	1929	9,016

Conditions in the Islands during the first two years of the century were rather unsettled. When peace was restored, it

was apparent that the importation of cattle was necessary, as there were not enough local animals left to supply the demand. From 1903 to 1909, inclusive, the importation was quite steady. There was a sudden jump in 1910. This was probably due to two causes: first severe epizoötics of rinderpest that had prevailed from 1907 to 1909, and secondly, the beneficial influences of the Payne–Aldrich Tariff Act on the prosperity of the Islands.

At this time the Bureau of Agriculture entered upon a campaign for the regulation, and if possible the prohibition, of the importation of animals from foreign countries infected with rinderpest and foot-and-mouth disease. A general order providing for a 90-day quarantine on cattle and carabaos coming from Hongkong was promulgated December 10, 1910. A similar order covering French Indo-China was issued on June 25, 1912. In effect this was the same as absolute prohibition. These measures were opposed by the sugar planters of Occidental Negros, who demanded Indo-China carabaos for work purposes and also by the population of Manila who were fearful about their supply of fresh beef. To relieve the situation for the City of Manila, a slaughterhouse was established across the bay at Sisiman for the slaughter of cattle imported from Australia. In 1913, the importation of carabaos from French Indo-China was resumed, subject to simultaneous inoculation against rinderpest.

After the outbreak of the World War the supply of cattle from Australia was cut off because of an embargo on the exportation of foodstuffs from that country to any but the Allied Countries. In consequence of this, the Government decided to again permit the importation of Asiatic cattle for slaughter. During the years 1916–17–18, a relatively small number of cattle were imported owing to the scarcity of steamers.

After the return to normal conditions, the local cattle growers renewed their demands for the prohibition of the importation of cattle from foreign countries for slaughter purposes. This resulted in the passage of Acts 3052 and 3155 on March 14, 1922, and March 8, 1924, respectively, both of which restricted the importation of live cattle.

Since April 1, 1925, all importations of cattle have come in under yearly permits authorized by the Governor-General, with the concurrence of the presiding officers of both Houses. This was in accordance with the provisions of Act 3155. These permits were extended from year to year. The last extension ex-

pired on July 15, 1930, the Government having decided to give the local cattle raisers an opportunity to supply all the fresh beef requirements of the home trade.

At the end of 1918, the number of cattle in the Philippine Islands was 600,173. At the end of 1928, it was 1,107,794. In ten years the number had almost doubled or an average increase of about 10 per cent a year. During this period there has also been a slight gradual increase in the amount of beef consumption in the provinces. In 1929, the number of native cattle slaughtered in Manila and the provinces totaled 156,865 head, or 14 per cent of the number on hand at the end of 1928. Since July 11, 1930, no live cattle have been imported from foreign countries. This means that the 1,732,453 kilos of beef furnished by the imported cattle will have to be taken care of by the local producers of cattle. To do this will require an additional 15,668 head on the basis of 110 kilos dressed weight per native animal. This is merely 1.4 per cent of the total number of animals in the Islands at the end of 1928. With an average yearly net increase in the cattle population of 10 per cent, a subtraction of another 1.4 per cent for slaughter should still leave a satisfactory annual increment. As a matter of fact, the ten provinces that now supply the major part of the native beef consumed on the Manila market should be able to take care of this addition without exceeding their average annual increase. Also, provinces such as Iloilo, Antique, Leyte, Ilocos Norte, Mountain, Zambales, Nueva Vizcaya, Isabela, and Cagayan that heretofore have furnished but few animals to the Manila market should now be in a position to compete.

The majority of the cattle raised in the Philippine Islands at the present time are in the hands of small owners. Seventy-two per cent of the total are owned by individuals who have from 1 to 50 head, while only 9 per cent are in herds of more than one thousand. The largest herd in the country has about 10,000 head. The Province of Batangas, which produces the best cattle in the Islands, supplies the Manila market annually with a considerable number of cattle. There the animals are practically all in the hands of small owners. Out of a cattle population of 62,359 only 369 are owned by a company having more than 100 head. The provinces having the largest herds are Bukidnon, Masbate, Leyte, Cotabato, Zamboanga, Palawan, Cagayan, and Tayabas.

From the first of August till the time of writing, about the middle of November, there has been an ample supply of cattle on the Manila market. As a matter of fact, for several weeks there was a glut as the arrivals were exceedingly heavy immediately after the first of August. It is therefore quite apparent that one of the big problems of the local cattle producers will be the regulation of the supply for the Manila market. In other words, there must not be periods of glut followed by corresponding periods of shortage. Furthermore, with the exception of Batangas and Ilocos cattle, which are mostly hand fed, nearly all the animals arriving from the provinces have come direct from the ranches. Such cattle do not stand long confinement in the corrals very well and lose weight heavily and deteriorate in quality if kept there long without special attention as to feeding. It is therefore to the advantage of both the producers of ranch animals and the consuming public that they should be slaughtered very shortly after arrival on the Manila market.

ILLUSTRATIONS

TEXT FIGURE

(a) A Batangas bul

(b) An Ilocos work bullock

PLATE I

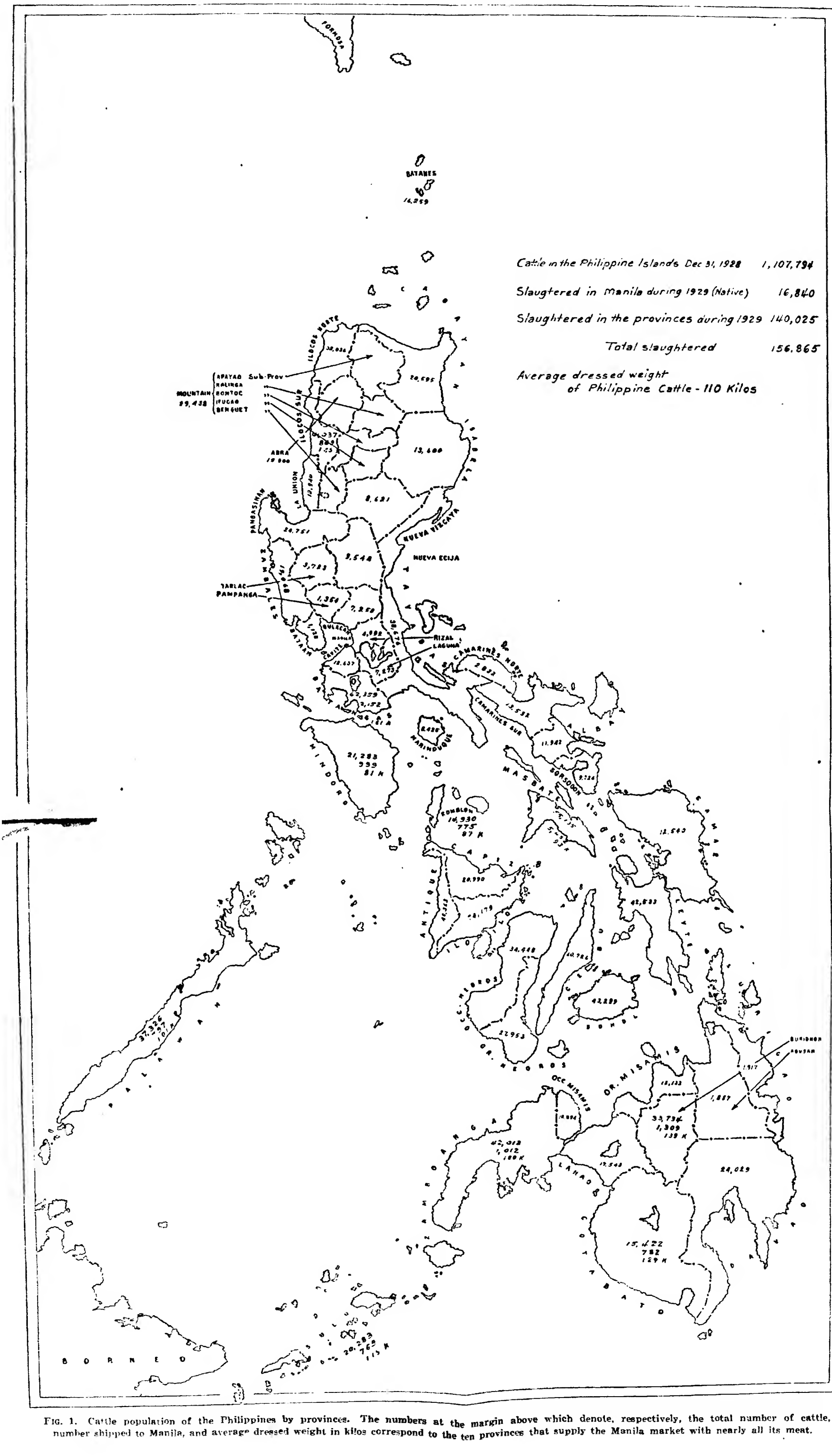

FIG. 1. Cattle population of the Philippines by provinces. The numbers at the margin above which denote, respectively, the total number of cattle, number shipped to Manila, and average dressed weight in kilos correspond to the ten provinces that supply the Manila market with nearly all its meat.

AVIAN PEST, A DISEASE OF BIRDS HITHERTO UNKNOWN IN THE PHILIPPINE ISLANDS

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FIVE PLATES

In September, 1927, the Veterinary Research Laboratory of the erstwhile Bureau of Agriculture was called upon to investigate an outbreak of a very destructive disease of poultry within the City of Manila, in the districts of Sampaloc, Malate, Ermita, Paco, Pandacan, and Quiapo. Since the disease was already widespread when it was discovered, the point of origin could not be traced. Within a month, aid was also asked by nearby towns and villages in Rizal, a province adjacent to the city. The Baclaran Poultry Farm in Parañaque, Rizal, owning not less than 500 chickens, had been the source of our experimental chickens, but in less than four weeks almost the whole flock became infected, not more than twenty escaping infection. Then the scourge was found in San Francisco del Monte, San Juan del Monte, and Malabon in the Province of Rizal, and San Pedro Tunasan, Calamba, Biñang, and Los Baños in the Province of Laguna. Within about two months the infected area had extended some 60 miles from Manila.

There are no large poultry establishments in the Philippine Islands except this one in Parañaque and another in Los Baños. Here a loss of not less than 80 per cent was estimated as a result of this outbreak. Not less than 200 poultry yards with an average of 60 fowls to a flock belonging to individual owners were visited. Since the alarm was not sent to the Bureau until many birds had died and almost all of the remaining ones were sick or infected, the mortality was high; in some instances even as high as 100 per cent. Where help was given early, many infected yards lost only those that were already sick or in the incubation period. In well equipped yards, the disease was not difficult to check.

The spread of this epizoötic was very rapid, but no official report from private persons or from Government field vete-

rinarians as to its presence in the more remote provinces was received. The pest in and around Manila turned out to be mild and only sporadic after the first flare-up. Cases reported in 1928, 1929, and 1930, came from Maypajo, Pasay, Taguig, Pasig, and Malabon in the Province of Rizal, and the districts of Santa Mesa, Santa Cruz, Quiapo, Malate, Sampaloc, and Ermita, Manila. The recurrent attacks of the disease in districts previously visited were usually not severe, comparatively fewer fowls contracting the disease (50 per cent) with a comparatively high percentage of recovery (30 per cent).

There was no particular part of the year marked by any special virulence of the disease. The months of September, October and the early part of November are rainy; the latter part of November, the months of December, January, and the first part of February are cold, dry months; in March, April, and May there is hot, dry weather; but during all of these months, when the first great outbreak was running its course, there was no difference in mortality; in fact, the latter half of 1927 and the first half of 1928 were a continuous period of the greatest loss of poultry in this section of the Islands from this new disease. At this writing, the virulence of the disease seems to have abated, only the village of Guadalupe, Pasig, Fort McKinley, and Pasay in Rizal, and Malate district, Manila, being known to harbor the infection.

The topography of the ground does not have a marked influence on the severity of an outbreak. Hilly ground, rolling land, level surfaces, and marshy places are all alike when this infection visits them. The most important factor as a source of infection of the whole flock seems to be a common pool to get water. The smaller the source, the greater the concentration of contamination and the better chance the disease has to get into every fowl.

Within the period from September, 1927, to September, 1928, it is estimated that 75,000 fowls died of this malady, and up to this time, November, 1930, approximately 140,000 chickens have died from it.

The nature of this scourge of poultry at first baffled all of the experienced men of the Bureau because the etiology, symptoms, and destructiveness were hitherto unknown. Major R. A. Kelser of the United States Army Medical Research Board, Bureau of Science, Manila and Dr. Earl B. McKinley of the Rockefeller Foundation, Bureau of Science, Manila, were consulted but they

expressed unfamiliarity with the new disease that confronted us.

The country from which this new pest was introduced into the Islands has not been traced. A review of literature on poultry diseases was unfruitful. There came to hand, during our study of this malady, a report, on the Newcastle disease by T. M. Doyle of the Veterinary Laboratory, English Ministry of Agriculture, and another on pseudo-fowlpest by W. K. Picard, Bacteriologist at the Veterinary Institute at Buitenzorg, Java, describing two diseases which very closely resembled this new poultry disease that we call "avian pest" in the Philippines. In the meantime, a disease of fowls called Ranikhet disease, with apparent similarity to these three diseases, was mentioned in a letter we received from Dr. T. M. Doyle as having been reported by the Chief Veterinary Officer of Ceylon and from the Imperial Bacteriological Laboratory, Muktesar, India.

All workers on these diseases believe this affection to be new and no one has as yet traced its origin. The identity of these four named diseases—the Newcastle disease, pseudo-fowlpest, avian pest, and Ranikhet disease—has been more or less ascertained by means of cross-immunity tests performed by an exchange of viruses. This laboratory initiated the idea of such exchange, and we have been successful in sending virulent virus to Java, England, and India by means of proper selection, preservation, and storage. Virus that came from these countries in exchange for ours was tested in the Philippine Islands and no essential difference could be noted as to the period of incubation, symptoms, and lesions. Fowls immune to avian pest were found also immune to the Newcastle disease virus, pseudo-fowlpest virus, and Ranikhet disease virus.

A preliminary report on this disease was published in the Proceedings of the Society for Experimental Biology, 1928, p. 25.

CLINICAL ASPECTS OF THE DISEASE

Avian pest is an acute, infectious, very fatal disease of the avian family attacking chickens, ducks, turkeys, guinea fowls, pigeons, parrots, and wild birds. It is characterized by fever in the first stage of the disease followed by an irregular or subnormal temperature. Inappetence, inactivity or slowness, diarrhea, gasping for air, mucous discharge from the bill, ruffled plumage, cyanosis, and wilting of the comb and wattles are the most common symptoms. Nervous twitching movements

of the head, the utterance of a shrieking sound, paralysis of the limbs, and emaciation are observed in birds that have recently recovered from an acute attack.

The symptoms of disease produced by artificial infection appear after a number of days, varying in accordance with the quality and quantity of virus introduced. A large dose of virus may cause the death of a fowl within two days with no other symptom than profound dopiness, closing of the eyes, diarrhea and ruffled plumage. This peracute course may be due to toxins accumulated in a concentrated virus or to a surcharge of antigen or to a multiplied production of lethal product by the presence of a large quantity of virus introduced. When an ordinary dose is given, for instance, 125 minimum infective doses, the symptoms appear three to four days after the injection, and in attenuated virus or in very dilute virus, the symptoms may appear even as late as 14 days afterwards. The average period of incubation observed in most of our artificially infected fowls is 4 to 5 days.

The first symptom of sickness is a rise in temperature, reaching as high as 44° C. in some cases which may stay high for one to two days. Then simultaneously follows a loss of appetite with an involuntary picking up of few choice grains offered. Later there is complete inappetence. During the first day, the fowl may still be active but in less than 24 hours the bird becomes slow of movement, and occasionally closes its eyes. There is a momentary ruffling of the feathers of the head, disturbance of the circulation as seen in the comb which becomes pale and shrinks to a certain extent and the feet become cold to the touch. Continuous swallowing movements due to increased salivation is noted, after which diarrhea sets in. The crop becomes distended with foul, sour-smelling gas or a dark, dirty brown liquid, or impregnated undigested grain. Continuous profuse diarrhea which, in fat birds, is often bloody, soils the fluff just beneath the vent and causes a very rapid cachexia. There seems to be an increased thirst, and it is during the process of drinking that much virus is liberated into the drinking trough. In natural infection, this is an important item. Synchronous with the rise of temperature a respiratory disorder manifests itself in dyspnea. Gasping for air becomes more labored as the disease progresses, and sometimes a sharp, shrieking, unique sound is uttered as if there was an unremovable obstruction in the respiratory passage. Dyspnea is not observed in all cases, but the cyanosis of the exposed portion of the head seen in most

cases may be due to this apparent inability of the inhaled air to supply the necessary oxygen. This shortage is probably caused by lung edema, or by a mucous clog of the respiratory tubes.

Moon blindness and cloudiness of the cornea may occur either as a primary lesion of the disease or as sequelæ in protracted cases.

A few cases with profound somnolence, sitting down, listlessness, head well drawn in between the shoulders, diarrhea, inappetence, immovableness, and death in the same position were observed.

In the more acute cases, tenacious, glary, stringy saliva dribbles from the bill. When this is not swallowed by the sick bird it may hang down several inches. These animals usually present a characteristic sleepiness and inattention to the environment. In such cases death occurs within two days.

When an animal is resistant enough to survive an acute attack, it either completely recovers or manifests nervous derangements which it may or may not ultimately get over. A bird that recovers without a nervous affection requires a little over a week to regain its former vivacity and its appetite, and excrete normal feces. Releasing an animal in this state to roam under field conditions hastens restoration to its natural vigor. In the few birds that show nervous derangements the resultant clinical picture is manifested by a persistent inappetence; as a result, the fowl dies from inanition and extreme emaciation in about 20 days. In other cases, these nerve tissue derangements result first in a slight unsteadiness of the head; later in its "making S's" when walking. Then, when the bird is let out to grass, recovery may ensue as a result of proper nourishment, fresh air, and exercise. In most cases, however, this symptom develops into a double twist of the neck which is straightened with the utmost difficulty by the fowl in attempts to pick up grain for food. In so doing, it may tumble sideways, forward or backward in its futile efforts. In one instance, a paralysis of the neck was noticed. Chronic spasms of the whole musculature may be observed in some recovered birds.

When the limbs are affected, there is a limpiness in gait or a drooping of the wings. This advances into a cessation of function of one or both limbs by paralysis. If one leg only is affected, the toes are curved in and the muscles atrophy. The joint may or may not become stiff. When both legs are paralyzed they are stretched backward and the fowl eats normally.

Life in such birds can be maintained by proper care for a long time, but the lack of exercise ultimately gives way to emaciation, unthriftiness, and death.

Cases that do not survive from the acute attack usually die in from two to four days after the onset of symptoms; so that seven days may be stated as the average course of the infection. Prolonged inappetence, lameness, nervous troubles such as chronic spasms, twitching movements of the neck, and complete paralysis of the limbs are sequelæ of fever and nerve injury and may, in our opinion, no longer be considered as stages of the disease. Moreover, those that show these symptoms are very few in comparison with the number of cases that terminate in death within an average of seven days.

All animals that recovered spontaneously or by the aid of treatment were immune.

FIELD OBSERVATIONS

Poultry owners here depend very much upon Government aid in the control of this disease in their flocks. This gave us an opportunity to study means to control it under field conditions and, in so doing, some first-hand observations were obtained.

The introduction of this disease into a poultry yard when it is not contiguous to an infected area is usually by means of fowls bought in the market. Unscrupulous vendors offer for sale the remaining number of an infected group of chickens that may be in the incubation period of the disease. In several instances, the practice of borrowing roosters or exchanging them has afforded a chance of scattering infection. Wild birds may play a rôle in the spread of the epizoötic. A sick wild bird may drink from the pool or may die on the premises; in this way also the disease may be introduced. Within an infected flock, the common drinking trough or pool is the most important source of contamination, as a sick bird is extra thirsty. During the process of drinking, especially when the crop is already full of water, some of the liquid in the crop in addition to the saliva is regurgitated into the drinking vessel or pool and thus contaminates it.

The infection wipes out about an average of 90 per cent of the fowls in a newly infected flock. The remaining 10 per cent may be grouped as those which develop paralysis and those that recover. The recovered cases are immune. We believe that in natural infection, varying amounts and varying dilutions of virus are ingested, so when the dilution is high or the amount

of virus is small, the animal may have an opportunity, during the slow process of virus propagation in the body, to build up resistance or immunity. In some places the whole flock has been annihilated by the disease.

When proper means of control by disinfection, isolation, and sanitation are applied, the disease when new in a locality is not difficult to control. Poultry owners, of course, must be equipped with isolation pens, and strict compliance with control measures must be enforced. This topic will be discussed further under the field control of this disease.

GROSS PATHOLOGY

EXTERNAL CHANGES

When animals die within two to three days after the appearance of symptoms, there is not much indication of morbid changes noticeable externally. The skin cannot be differentiated from that of a normal fowl when the feathers are plucked in killed animals. In fact, experimentation to detect any clue to differentiate by external examination between normal fowls and sick fowls bled and dressed in a similar way has been fruitless. Therefore, when a vendor dresses a newly sick fowl and offers the meat for sale, meat inspectors find it impossible to single out the unwholesome bird. The mucous coating of the buccal membrane may no longer be noted when the fowl has been cleaned and stored for some time in the refrigerator. The hemorrhages on the skin in the thoracic and abdominal regions observed by Picard(2) have never been noticed by us.

In cases that die a longer time after the appearance of symptoms, marked shrinkage of the wattles and comb, and also of the shanks, and a general emaciation are manifest.

INTERNAL CHANGES

1. *Bony structure.*—The occipital, frontal and parietal bones are found to be highly congested in a number of cadavers. Dark-red areas are also seen on the breastbone and hipbone.

2. *Brain.*—The brain substance does not show any marked change but the meninges are sometimes hemorrhagic or congested.

3. *Heart.*—Petechiæ on the epicardium and endocardium are observed in a few animals, especially among those that are fat and in prime condition. The pericardial fluid is increased only in a very limited number of infected fowls.

4. *Respiratory tract.*—The nostrils are not clogged with liquid exudate as in colds, but the buccal mucous membrane, pharynx, and trachea show a decidedly catarrhal condition, as a consequence of which there is a thin deposit of a glary, tenacious mucus. Petechiæ have been observed in a few cases on the mucosa of the bills and also in the pharynx. The lungs are not very much changed as a rule, but occasionally congestion, emphysema, and edema are found.

5. *The digestive tract.*—The most important seat of lesions is the digestive tract. The œsophagus presents a marked hemorrhage of the serous layer. This suggillation sometimes extends as far down as the crop, and prevails in about 20 per cent of acute cases terminating in death. The mucous membrane of the crop suffers a severe desquamation, which gives its liquid content turbidity. In two instances ecchymoses were detected in the crop mucous membrane. When the animal is taken sick while the crop is full of grain, this remains undigested and the animal may die with its crop full. If the animal is taken sick while the crop is empty, the crop content is a whitish semi-transparent liquid, the opacity being caused by cell desquamation. This kind of crop content is very virulent and the virus in it can be kept viable and virulent in the Frigidaire for months. With a little fermented food in the crop, the content becomes either a yellowish or brown, dirty, foul, and sour-smelling liquid which, if stored in the Frigidaire, does not maintain a live virulent virus for a long time.

The fat around the gizzard is studded with petechiæ and the smooth surface beneath the cuticle of the gizzard is very often the seat of ecchymosis. The mucous membrane of the proventriculus is characterized by an almost invariable hemorrhage of some kind—from petechiæ to extensive hemorrhages on the surface without oozing of blood. The duodenum is swollen, diffusely inflamed and covered with a catarrhal exudate. The jejunum, ileum, and ileo-cæcal valve are spotted with hemorrhages ranging from pin point to millet seed-sizes. The rectum is streaked with linear hemorrhage, and the cloaca is diffusely and intensively reddened.

6. *The generative organs.*—No lesions of any importance have been observed in these. In very fat hens there was a peculiar characteristic obnoxious odor and the ovaries were markedly inflamed. The oviduct was also congested. In males, no appreciable change was noticed except petechiæ on the cuticle of the testis of one of the roosters autopsied.

7. *Spleen.*—No lesion of note except one with petechiæ.

8. *Liver.*—No lesion to attract attention. Focal necrosis was seen in some instances.

9. *Kidneys.*—May or may not be congested. White spots (urate deposits) were observed in prostrated cases, but this may have been due to nutritional disturbances.

10. *Nerve center.*—The brain and nerves were carefully dissected from paralytic and non-paralytic cases in an effort to find the nerve enlargements of *neuro-lymphomatosis gallinarum* reported by Pappenheimer and his co-workers(3) and in chicken neuritis reported by Doyle(1) but no such enlargements were found. Spinal cords and femoral nerves carefully dissected from paralytic hens were sent to Doctor Pappenheimer for study. Doctor Pappenheimer reported that he found no enlargements nor the characteristic lymphamatosis of their fowl paralysis in the several specimens sent to him.

11. *Subcutaneous tissue.*—A gelatinous infiltration is often seen under the skin extending from the base of the neck to the thoracic inlet. This material was fed to a susceptible fowl and was found to be non-infective.

BACTERIOLOGICAL EXAMINATION

All attempts to isolate bacteria from the blood and internal organs ended with negative results. Many different kinds of stains were employed without success. Several aërobic and anaërobic media including chicken blood were found to be valueless. Bacterial cultures from the intestinal tract did not produce the disease when introduced into fowls in different ways. A diplococcus-like organism was isolated from the blood collected by cutting the throat, but this did not produce the disease.

HISTOLOGICAL EXAMINATION

Various sections from the liver, spleen, lungs, proventriculus, and œsophagus were made, but there were no important changes except hemorrhage. No inclusion bodies in the nerve cells were noted by staining smears and impressions with Seller's stain.

The histological picture of the brain and cord, which may explain the locomotor disturbances in affected animals, is given by Dr. Pappenheimer in one of his letters as follows:

> * * *. There are quite marked lesions especially in the spinal cord where many of the vessels were surrounded by mantles of lymphoid cells and there were wandering cells also scattered irregularly through the central grey. Many of the anterior horn cells showed intense degeneration, sometimes complete necrosis. In the brain itself, I found occasional

perivascular infiltrations. The peripheral nerves were either normal or showed purely degenerative changes, probably secondary to the spinal cord lesions. In one or two blocks there was a sparse infiltration of lymphoid and plasma cells between the fibers, but none of the blocks showed a massive infiltration such as we have regularly found in our paralyzed birds here. * * *.

INCUBATION PERIOD

The period of incubation varies with the amount and quality of virus introduced into the system. A very dilute, attenuated, or a very minute quantity of virus may induce disease after a prolonged period running up to about 14 days. An ordinary dose of ordinary virulence, say 5 to 125 minimum infective doses, causes the appearance of symptoms in 3 to 5 days. On the other hand, a concentrated or a large amount of virus may produce the disease one day after the injection and kill the fowl on the second day. In natural infection, this variation occurs, but as a rule the incubation period is from 3 to 5 days.

COURSE OF THE DISEASE

This disease runs an average course of 7 days from the time the virus is given but of only 2 to 4 days after the symptoms have appeared. Chickens that have passed the crisis of the disease may recover within 1½ weeks or may be permanently deranged and ultimately die. In our opinion, the sustained nervous symptoms appearing after a bird has recovered from an acute attack are but sequelæ resulting from nerve injury. It is impossible to transmit the disease from these fowls, as they are immune after recovery. Neither are they carriers.

DIAGNOSIS

The diagnosis of this disease is quite simple in territories where it prevails. The anamnesis, symptoms and lesions are quite characteristic. The experienced person rarely fails to recognize avian pest when a bird is presented for diagnosis.

To verify a clinical diagnosis, an emulsion of the spleen, liver, kidneys, brain, testes, or liquid crop content may be injected into a susceptible fowl. The disease develops in from 2 to 20 days, the average incubation period being 4½ days.

A bacteriological and cultural study of the tissues fails to disclose the presence of microscopically visible organisms. When, therefore, a sick or a dead fowl does not reach the laboratory in a suitable condition a laboratory diagnosis is imposible. If the distance is great a specimen had better be shipped in cold storage, to ensure the receipt of a virulent virus.

An attempt was made to remedy this difficulty by the use of serological reactions, since serum could be transported at ordinary temperatures without destroying its ability to fix complement.

Six different antigens were prepared as follows: (1) Dry spleen, liver, and brain desiccated in the Frigidaire were pulverized in a mortar. The fat in the powder was extracted with ether by placing the mixture one day in the incubator at 37° C. after which the ether was removed by decantation and evaporation. Then an extract was obtained from the residue by the addition of 2 parts of absolute alcohol to 1 part of the powder, the mixture placed in an incubator at 37° C. for one week, frequently shaken. The filtrate constituted the antigen. (2) Same process of manufacture as (1) except that absolute methyl alcohol was used instead of ethyl alcohol. (3) Fresh liver of a sick fowl was weighed and then ground into a paste. Ten parts of absolute ethyl alcohol was added to one part of the paste and the mixture ground together. The bottle containing the mixture was placed in a water bath at 70° C. for an hour with frequent shaking. The alcoholic extract which passed through filter paper constituted the antigen. (4) Fresh spleens from sick fowls were ground with physiological saline, pH 7.6 (1 part brain, 10 parts saline). The resulting emulsion was filtered through paper. The filtrate constituted the antigen. (5) Fresh brains from sick fowls were treated in the same way as (4). The filtrate constituted the antigen. (6) Liquid virus composed of a mixture of liquid crop contents plus 30 per cent Sorensen's phosphate mixture, pH 6.8. The positive serum was taken from a sick fowl.

As shown in Table I there was no trace of complement fixation in any of the antigens used.

TRANSMISSION OF THE DISEASE

NATURAL INFECTION

Owing to the highly infectious nature of the saliva and crop contents, the disposition of the sick animals to drink large quantities of water, due probably to the fever or diarrhea, and the ease by which birds are infected per orem, it is logical to suppose that under field conditions the common drinking trough or pool is the most dangerous source of infection. During the dry season in tropical countries, when there are at best only one or two troughs or a shallow pool from which all chickens take water, there is, in case of outbreak, a wholesale infection

which may even result in total annihilation of the poultry on a farm. This is true because the water becomes highly contaminated with virus from one or two sick birds and the dose ingested by the well ones is enough to produce the disease in a severe form. But in an outbreak during the rainy season, when fowls are allowed to roam at large and drink from well drained ditches, many chickens either escape infection or are only slightly affected and recover. This may be explained by the possible ingestion of a very dilute virus, just enough to induce immunity.

Fowls become infected by feeding on ground that has recently been contaminated with virulent virus. It has been apparent from our work that the virus infects a healthy animal in natural infection by way of the digestive tract only.

Exchange of respired air has no effect in imparting disease from one fowl to another.

Nothing is known about the part taken by insects or other agents in the transmission of the disease.

ARTIFICIAL TRANSMISSION

Different routes of artificial infection were studied in order to ascertain means by which to control the disease. Virus was introduced into the body by way of the digestive tract and other natural openings, under and on the skin, into the muscles, and into the anterior chamber of the eye.

1. *Subcutaneous route.*—Fowls injected with virulent virus succumbed to subcutaneous infection.

2. *Intramuscular.*—The disease can be produced by this means.

3. *Conjunctival.*—One to four drops of virulent virus taken from the crop contents and instilled into the conjunctiva produced the disease in one of four trials. It is possible that when the virus is dropped into the eye and no virus enters the lacrymal duct no infection may result, but it is quite difficult to avoid some virus being swallowed, so this route may result in the involvement of the digestive tract. In which case we cannot assign "conjunctival" as a distinct and separate route.

4. *Intravenous.*—Infection results by the intravenous route of introducing the virus.

5. *Intra-ocular.*—The introduction of $1/10$ cubic centimeter of virus into the anterior chamber of the eye by the use of the intradermal syringe graduated to $1/100$ cubic centimeter causes

infection. Rabid-like symptoms, cloudy cornea and defective locomotion were manifested.

6. *Cloacal.*—Out of four trials, one fowl developed the disease.

7. *Scarification.*—Scarification of the comb and saturating the scarified area with virulent virus resulted negatively in four trials.

8. *Per orem.*—Virus fed to susceptible fowls caused the disease. This way of infecting chickens with either liquid or solid food is very significant in efforts to check outbreaks.

9. *By coitus.*—Coitus is not in itself dangerous aside from the possibility of the head feathers of the hen being infected with virus.

10. *By contact.*—Actual contact of well with sick birds is not a factor in transmission unless opportunity is given to inject the virus. When sick and healthy fowls were placed in cages, infection invariably resulted, because there was always a chance for the healthy chickens to drink from the trough used by the birds in the morbid state. It is known from experiments that very dilute virus fed to susceptible fowls causes the disease.

11. *By skin trauma.*—The skins of young fowls were artificially pricked with the beaks of sick chickens. In no case did infection result.

12. *By the respiratory tract.*—No case of transmission by an exchange of respiration has been recorded. Healthy fowls did not contract the disease when placed in cages next to those containing sick ones.

13. *Insects and other agents.*—No study was made on this phase of the problem.

ETIOLOGY

Many attempts were made to isolate and culture the causative organisms of this disease, but without success. In some cases, when examining stained smear preparations of blood obtained by cutting the throat of sick birds, a very minute diplococcus was found, but this organism proved to be without relation to the disease. After futile efforts had been made to incriminate bacteria, protozoa, vegetable or mineral poisons, we proceeded to inject body fluids and emulsions of organs from sick to well birds in an effort to discover the causative agent. When we knew which organs and liquids were virulent, we filtered emulsions of organs and body fluids through Berkefeldt filters.

Since the filtrates were found to be infective, we concluded that the cause of this disease must be a filterable virus.

NATURE OF THE VIRUS

HOSTS

This virus attacks turkeys, ducks, pigeons, guinea fowls, chickens, parrots, and wild birds. Three varieties of wild birds, one of them belonging to the *mayas*, another to the martins and one not identified, were caught in the cattle sheds and injected with the virus. While they did not show gasping, diarrhea and "dopiness" were noted. Death occurred on the second day after injection. In the case of the *mayas* bought from bird dealers, death followed five days after feeding with contaminated water.

Cats, rabbits, guinea pigs, white rats, swine, and sheep injected with virulent virus did not contract the infection.

FILTRATION

Before we knew the electrical charge of the virus, we attempted to pass the fluid of an emulsion of organs through Berkefeldt candles. We employed new Berkefeldt V, N and W candles after washing them thoroughly with distilled water. They were controlled by the use of an emulsion of *Pasteurella aviseptica* culture less than 24 hours old.

The chief component of Berkefeldt filters, Kieselguhr, consists of the siliceous shells of diatoms, and its electrical charge as determined by endosmosis (5) is negative. Since this virus is also negatively charged, the problem of adsorption was eliminated. In fact, no difficulty was encountered in obtaining virulent material from the filtrates even in the case of the W Berkefeldt candles.

AFFINITY OF THE VIRUS FOR DIFFERENT ORGANS OR TISSUES

The spleen, kidneys, ovaries, testes, liver, lungs, intestines, and brain of sick fowls were carefully recovered with separate, sterile instruments and separately introduced into experimental birds. These organs were found to be virulent. Freshly obtained whole blood, five-tenths per cent phenolized blood, blood serum, and washed red blood cells, injected subcutaneously, intravenously and given through the mouth were found not capable of producing the disease. Whole blood freshly drawn and transfused intravenously into two chickens infected and killed them. In one instance, the subcutaneous injection of Berkefeldt filtered

laked blood was successful in producing the disease. Pooled serum obtained from coagulated blood taken from several sick birds caused a mild infection, but the birds recovered and when tested later, were found to be immune. Pooled serum obtained by centrifugation did not produce the disease.

The saliva and crop contents are very virulent either in high dilutions or in minute quantities. Liquid virus can be stored in the ice-chest for a long time.

In several experiments the feces was found to be rarely virulent. In our experiments we mixed feces obtained at various stages of the disease and mixed with soft feeds. In only one instance did feces fed to a fowl produce the disease. In this case we presumed that there might have been considerable cellular elements from the intestinal tract present in the feces, as scrapings from the mucosa of the intestinal tract contain virulent virus.

The gelatinous infiltration that collects at the thoracic inlet of fat fowls was found not to be capable of producing the disease.

THERMOLABILITY OF VIRUS

Liquid virus in amounts of 2 cubic centimeters each was placed in thin glass vials and sealed. The vials were then placed in wire baskets immersed in a water bath at a temperature of 5° C. below that at which the virus was to be subjected. Frequent but gentle shaking was done to insure uniform heating. The temperature was then raised to and maintained at 75° C., 62° C., 55° C., 50° C., 42° C., and 37° C. for 30 minutes. It was found that virus kept at 75° C., 62° C., and 55° C. was rendered innocuous, but that kept at 50° C., 42° C., and 37°C. caused infection. Virus kept at ice temperature can be kept alive for several months; and frozen virus, like the one received from India, is viable and virulent. Amos *et al.*(5) state that all viruses are inactivated by heat varying from 45° C. to 80° C. Avian pest virus dies between 50° C. and 55° C. with an exposure of 30-minute duration.

EFFECT OF DIRECT SUNLIGHT ON VIRUS

Dilute crop contents were placed in petri dishes and allowed to float on water which filled a large basin. Then the basin and the petri dishes were exposed to the sun from 10 a. m. to 1 p. m. at different lengths of time; namely, 30 minutes, 1 hour, and 3 hours. The purpose of the water was to prevent overheating.

A thirty-minute exposure was sufficient to kill the virus. This information is valuable in the field control of the epizootic.

EFFECT OF DRUGS IN VITRO

Several drugs were used to ascertain which is the best for field control.

1. *Clenzal.*—Fresh clenzal in 2½ per cent strength in distilled water kills the virus in 30 minutes.

2. *Formalin.*—One per cent and 2 per cent kills the virus in 30 but $\frac{1}{10}$ and $\frac{5}{10}$ per cent formalin (37 per cent formaldehyde) Mallinckrodt U. S. P. do not kill the virus in 30 minutes.

3. *Chloroform.*—One per cent chloroform kills the virus in 30 minutes, but $\frac{1}{10}$ per cent chloroform has no effect on the virus in 30 minutes' exposure at ice-box temperature.

4. *Hydrochloric acid.*—Dilute crop contents containing 500 minimum infective doses of virus were treated with HCl of different normalities and placed in the ice-chest for one hour. One cubic centimeter of N/1 killed the virus, but N/10, N/50, N/500, N/2500 did not inactivate it.

5. *Sodium hydroxide.*—N/1, N/10, N/50, N/500 and N/2500 were contaminated so that every cubic centimeter of the alkaline solution contained 500 minimum infective doses. All chickens injected intravenously with N/2500 up to N/50 died immediately after injection, so no result was obtained. Therefore the N/1 and N/10 solutions were not used.

6. *Potassium permanganate.*—Twenty-five cubic centimeters of potassium permanganate solution in dilutions of 1 : 2000, 1: 14000, 1: 5000, and 1: 10,000 were used for every 2½ cubic centimeters of dilute crop content taken from a sick fowl, and this was fed to susceptible fowls after allowing the drug to act for 40 minutes. None of these fowls contracted the disease. Two and one-half cubic centimeters of the same virus was put into 25 cubic centimeters of tap water and fed in the same manner. The bird used as a control developed a typical case of the disease and was killed on the fifth day of injection. A dilution of at most 1: 10000 was found to be sufficient to make the virus innocuous.

EFFECT OF SERA

1. *Mammalian sera.*—One cubic centimeter of sheep serum plus 5 M.I.D., 25 M.I.D., and 125 M.I.D. of virus, respectively, were shaken mildly but thoroughly until a thorough mixture was produced. With the mixture of 1 cubic centimeter plus 125

M.I.D. and 1 cubic centimeter plus 5 M.I.D. no disease was produced, but with the mixture of 1 cubic centimeter plus 25 M.I.D., disease was produced although the animal recovered.

2. *Immune serum.*—From ¼ cubic centimeter to 1½ cubic centimeters each of fowl immune serum was added to 125 M.I.D. of titrated virus mixed in vials, mildly shaken, and placed for 24 hours in the ice-chest at 0° C. to 1½° C. The mixtures were injected intravenously. As a result of this experiment we learned that 1 cubic centimeter to 1½ cubic centimeters of serum was enough to neutralize 125 M.I.D. of virus, as birds receiving these amounts remained well. We recognize the fact, however, that the serum obtained from different animals may vary as to potency. The one-fourth to ½ cubic centimeter mixtures delayed the reaction to the 14th day. Subsequently the birds showed derangement, manifested in the head, but followed by complete recovery. Subsequent injection of virulent material proved the three recovered animals to be immune. The control bird became sick and died with good symptoms and prominent lesions.

MINIMAL INFECTIVE DOSE OF DILUTED VIRUS

The virus used in this experiment was dribbling saliva collected from the beak of an animal about to die from the disease. A series of dilutions in sterile distilled water was prepared and injected intravenously. The minimal infective dose for the virus used was thus established as 1 cubic centimeter of a 1 : 1250.

We considered 1 cubic centimeter of a 1 : 1250 dilution as 1 M.I.D. or 1 cubic centimeter of a 1 : 10 dilution as 125 M.I.D. It is, however, possible that the virus may not be infective in the same ratio if very high dilutions are used.

CATAPHORESIS

The results of filtration are modified by the electric charge carried by the filter and the material to be filtered. For this reason an attempt was made by the use of a simple method devised by Bedson and Bland(4) to find out the charge carried by this virus.

Technique.—A piece of blotting paper was first tried with methylene blue and eosin solutions, separately, to ascertain whether it was charged negatively or positively. Fixation of the methylene blue at the bottom of the paper near the surface of the solution and the rise of the eosin several centimeters

above the surface of the liquid demonstrated that the test paper was negatively charged.

Having ascertained the charge carried by the blotting paper, that possessed by avian pest virus was ascertained in the following manner:

Strips of blotting paper 0.5 centimeter by 18 centimeters were cut and marked in pencil 0.5 centimeter and 2½ centimeters from one end. Two pairs of strips were used in this test, which were held parallel with a bamboo clip.

Twenty cubic centimeters of dilute virus (crop contents) was added to 80 cubic centimeters of Sorensen's potassium and sodium phosphate mixtures, pH 7.731 and 6.813. One cubic centimeter of this mixture contained not less than 125 M.I.D. of virus. The liquid held by 2½ centimeters strip would, therefore, contain not less than 5 M.I.D. of virus. The lowest 0.5 centimeter of the blotter strips was placed under the surface of the contaminated buffers, and the whole set placed in a box at 14° C. until the liquid rose to the top of the 2½ centimeters mark. Then the strips were cut into 5 cubic centimeters sterile distilled water, macerated and filtered. One cubic centimeter each of the filtrate was injected subcutaneously into susceptible chickens.

Both strips from the virus in pH 7.731 mixture proved to contain enough virus to produce disease and one from the mixture at pH 6.813. One tenth of one cubic centimeter of the mixture at pH 7.731 injected into a control fowl proved fatal.

From this experiment we conclude that the avian pest virus possesses a negative charge.

CENTRIFUGATION

The centrifuge used was the International Electric Centrifuge No. 2 A. C. 220 volts, weight of load 320 grams adjustment No. 18; time 20 minutes.

The virus used was in the form of dilute pooled crop contents; crop contents in 50–50 glycerine saline mixture, and 1 : 1 : 1 crop content, glycerine, saline mixtures. After centrifugation the supernatant liquid was injected intravenously and subcutaneously in ½ cubic centimeter and 1 cubic centimeter doses. In every case disease was produced, but out of 6 trials the 2 which recovered were found to be immune.

Centrifugation did not throw down the virus from the suspension.

VIRULENCE OF VIRUS BY AGING IN DIFFERENT WAYS

In pure glycerine.—Heart and spleen placed in pure glycerine kept in the ice-chest (0°–2° C.) remained virulent for 175 days in one trial.

Dried over $CaCl_2$.—Spleen, brain, kidney, and liver cut into thin strips and dried over calcium chloride in a desiccator and the whole system placed in the ice-chest (0°–2° C.) remained virulent for 5 months and 18 days in one trial.

Dried over H_2SO_4.—The same as over $CaCl_2$.

Covered with earth.—Spleen and liver were placed in a petri dish and then covered with dry, sandy earth and placed at room temperature for 12 days. Five cubic centimeters of the emulsion were fed to two chickens without producing disease.

At room temperature.—Virulent crop contents absorbed by absorbent cotton and allowed to dry at room temperature became inactivated in 5 days. Liquid crop contents stored in a cotton-stoppered test tube remained virulent for 15 days. A Berkefeldt "W" filtrate did not lose virulence after exposing it at room temperature for 1 day.

At 37.5° C.—Virus in dilute crop contents became inactivated by storage at 37.5° C. for 3 days.

At ice-chest temperature (0°–4° C.).—Liquid crop contents suspended in distilled water and kept in cotton-stoppered flasks remained virulent for 5 months and 11 days. Organ emulsions in distilled water sealed in glass tubes became inactivated in 2 months and 18 days. Organ emulsions in distilled water kept in bottles plugged with cotton remained virulent for 1 month and 5 days. Crop contents preserved in glycerin-water solution (50–50) became innocuous in 4 months and 20 days; crop contents placed in 50 per cent physiological saline solution and 33⅓ per cent glycerine was inactivated in 2 months and 26 days. Berkefeldt "V" filtrate of crop contents suspension in distilled water remained virulent for 1 month and 22 days in cold storage. Dilute liquid crop contents in distilled water plus 30 per cent Sorensen's phosphate mixture of pH 6.8 with a final H-ion concentration of pH 7.2 has now remained virulent for 320 days. It is being kept for further test of virulence.

Virus in garden soil.—Garden soil was collected from a nearby field known to be free from any chicken disease. Fifty cubic centimeters of diluted pooled crop contents was well mixed within it and the moist earth covered with a piece of rough glass to provide diffuse sunlight. After being thus exposed for

4 days, the heavily contaminated earth was mixed with cooked rice moistened with water. Then two chickens starved for two days were allowed to eat the mixture. This procedure was repeated with another pair. None of the birds in this experiment contracted the infection.

Virus in stagnant water.—The bottom of a large beaker was covered with clay and 2 liters of tap water added. To this 50 cubic centimeters of liquid crop content obtained from several sick chickens were poured in to heavily contaminate it. This simulated a pool. After 4 days two chickens which did not have water for one day were allowed to drink *ad libitum* from water obtained from the beaker. This procedure was repeated. The four chickens that were experimented upon remained well, but succumbed when fresh virus was fed to them.

Virus in dead animals.—An emulsion of spleen in distilled water taken from 36 to 168 hours after death was injected subcutaneously in ½ cubic centimeter doses. In all except one kept for 72 hours, transmission was effected.

The foregoing experiments were conducted with a view to ascertaining the best way of keeping the virus alive for the continuation of this study and how it can be destroyed and eliminated. It appears that we can keep the virus active in either a liquid or dried form. Pure glycerine has been found to be satisfactory in preserving the virus in whole organs. Distilled water or phosphates buffer are the most satisfactory diluents for clear liquid crop contents. Virus in dried form does not persist in virulence for more than 5 days at room temperature. At a temperature of 37.5° C., viability is lost in 3 days.

AVIAN PEST AND FOWL PARALYSIS (NEURO-LYMPHOMATOSIS)

At the beginning of our study, it occurred to us, in view of the paralytic nature of many specimens obtained from the field, that there might be a similarity between *neuro-lymphomatosis gallinarum* reported by Dr. Alvin Pappenheimer, Leslie C. Dunn, and Vernon Cone(3) and avian pest. In order to find out whether nerve cords from paralytic cases found in the Philippine Islands contained the lymphoid infiltration reported by them, several nerve cords and brains preserved in formalin and in Zenker's fluid were sent to Dr. Alvin Pappenheimer of the Department of Pathology, Columbia University. He wrote us in part:

> * * *. I shall have histological sections made and will send you a set together with a description of any abnormal findings. From what

Doctor McKinley has written me, I rather believe that the epidemic disease which you are studying is different from the 'neuro-lymphomatosis' with which we have been concerned. * * *.

In a subsequent letter he said:

> * * *. The lesions in the two diseases resemble each other, but in your case, it appears to be the spinal cord which is most intensely infected, whereas in ours, the peripheral nerves are most often affected. * * *.

From Doctor Pappenheimer's reports it seems that avian pest and fowl paralysis are different diseases.

CROSS-IMMUNITY TESTS

Avian pest versus pseudo-fowlpest.—Upon knowing that there was a fowl disease reported to be new in Java, we made arrangements to exchange viruses. The virus we sent to Dr. W. K. Picard, Bacteriologist at the Veterinary Institute at Buitenzorg, was found by him not different from that of theirs from the results of his experiments on susceptible and immune Javanese fowls. The Director of the Institute wrote about the Philippine virus in part as follows:

> * * * It will be of interest to you to know that we could not observe any difference between the effect of various inoculation experiments either if we used "Java Virus" (Pseudo-Fowlpest) or "Manila Virus" and that owing to these facts we conclude that the chicken disease of the Philippine Islands is the same as Pseudo-Fowlpest. * * *.

The virus of pseudo-fowlpest received by us was inoculated into 9 immune fowls and 3 susceptible ones as control. We made a mixture of aqueous emulsion of organs and saliva and then introduced one cubic centimeter of this mixture intramuscularly, subcutaneously, intravenously, orally and intraperitoneally. Seven immune fowls remained well throughout the experiments, two immunes died instantaneously after giving the intravenous injections, and the three controls died in 5, 6, and 7 days after giving the Java virus. All of these showed the typical diarrhea, gasping for air, inappetence, ruffled plumage, and the hemorrhages in the intestinal tract especially the proventriculus, caeca and rectum. No essential difference as to temperature reaction, incubation period and course of the disease was noted between the disease caused by pseudo-fowlpest virus and that of the Philippine (avian pest) virus. We conclude that pseudo-fowlpest and avian pest are immunologically identical.

Avian pest versus Newcastle disease.—Arrangements were also made for the exchange of avian pest virus and the Newcastle disease virus. Dr. T. M. Doyle of the Veterinary Laboratory, Ministry of Agriculture, England, was kind enough to perform cross-immunity tests with the Philippine virus and sent a report of his results to us. He said in part:

> * * * I am attaching the results of some cross-immunity, and serological, tests undertaken with the two viruses. They are apparently immunologically identical. You are at liberty to make any use you like of these results. * * *.

Doctor Doyle found the saliva in glycerine-saline virulent upon arrival in London, but the brain and spleen were no longer infective.

The data of results sent by Doctor Doyle shows with good controls that fowls immune to Newcastle disease are also immune to the Philippine virus. He also found that Newcastle disease immune serum neutralized Philippine virus.

With regard to the Newcastle disease virus received by us, the summary of our results follows: The tube containing spleen in 50 per cent glycerine was tried in a set of 4 immune and 2 susceptible fowls. The two controls died with typical avian pest symptoms and lesions. One tube containing saliva in 50 per cent glycerine was injected intramuscularly undiluted in 1 cubic centimeter dose to 4 immune fowls and 2 susceptible ones. All of these remained well. The spleen in tube No. 2 and the saliva in two tubes were made into an emulsion and injected by 1 cubic centimeter dose to 8 immune fowls and two controls. One of the controls became sick and died in 7 days and the other became sick 8 days after injection and recovered. All of the eight immune fowls remained well. The mixture at ice temperature for one night of avian pest immune serum plus Newcastle disease virus in saliva and avian pest immune serum plus Newcastle disease virus in organ emulsion resulted in the neutralization of the virus. This affords a check-up of the serological neutralization tests made on avian pest virus by Newcastle immune serum. Three fowls immunized by the use of avian pest vaccine remained well during the experiments, and the two controls became sick and died with typical avian pest symptoms and lesions. Our experiments lead to the conclusion that avian pest and Newcastle disease are immunologically identical.

Avian pest versus Ranikhet disease.—Upon receiving the report of Doctor Doyle that a new disease of poultry was present

in Ceylon and in India, as stated by the Chief Veterinary Officer of Ceylon and the Imperial Bacteriological Laboratory in Muktesar, India, we wrote to the Pathologist of Muktesar offering to exchange viruses. We succeeded in sending virus to India through the kindness of the agents of Nippon Yusen Kaisha, Warner, Barnes & Co., Ltd. Dr. Hugh Cooper, Officiating Director of the Imperial Institute of Veterinary Research, Muktesar, India, with the coöperation of R. T. Davis, I. V. S., Principal, Bengal Veterinary College, Belgachia, Calcutta, received the avian pest virus and Newcastle virus we sent them in good condition. Doctor Cooper's letter regarding these viruses states in part:

> * * * The result of this preliminary experiment has been most instructive. You will see in the table below that 2 healthy and 2 fowls that were known to have recovered from "Ranikhet Disease" were injected with material from each tube you sent, and our "Ranikhet Disease" virus was also included. The recovered fowls were all solidly immune, whereas at least one tube of each of the viruses you sent was virulent. The fowls that died in all cases showed identical appearances with an "Ranikhet Disease." It would seem that the three viruses are identical. * * *.

Exchange of viruses between India and the Philippine Islands is most difficult because no direct steamers ply between these two countries, but through the efforts of Doctor Cooper, we also received from him virus which was in perfect condition when received. The virus had to be extracted from the frozen sawdust in which it was embedded. The saliva in the tubes was also frozen.

All of the tubes—five of them—containing whole organs in pure glycerine, emulsion of organs in distilled water, crushed organs without any liquid, and saliva in distilled water, were found to contain live, active virus. Of the six immune fowls injected with saliva and mixed emulsion of whole organs, and the emulsion of organs from India (3–3–30 to 3–28–30) none became sick. Again, with the spleen of one fowl that succumbed to the saliva from India, two susceptible fowls and two immune fowls were injected. The two controls became sick and died and the immune birds remained healthy. No difference in the symptoms and lesions shown by the susceptible fowls was noted in comparison with those that became sick and died from avian pest.

From these results we believe that avian pest and Ranikhet disease are identical diseases.

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In view of the conclusions obtained by the different workers on a disease which was independently studied and the evidences gathered by cross-immunity tests performed in Java, England, India and the Philippines, we arrive at the conclusion that pseudo-fowlpest, Newcastle disease, Ranikhet disease and avian pest are identical diseases.

TREATMENT

Experiments on the treatment of avian pest with various drugs.—In an attempt to satisfy the insistent demand made by poultry owners for a medium which would cure their sick fowls, we tried the curative effect of the following: (1) Hizon's phenamethylene, (2) clenzal or electrolytic hypochlorite of soda, (3) sodium cacodylate, (4) creolin, (5) arsacetin, (6) arsenic iodide, (7) indol, (8) mercurochrome soluble–220, (9) glucose, (10) strychnine sulfate, (11) quinine and urea hydrochloride, (12) gold chloride, (13) introcid, (14) acriflavine, (15) New-Salvarsan, and (16) Fowler's solution. Of these drugs, only the following showed promise when used therapeutically: Hizon's phenamethylene, gold chloride, introcid and Fowler's solution.

Hizon's phenamethylene is a proprietary preparation manufactured locally. It is claimed by the makers to be non-toxic when used intravenously. In our hands, single injections of one and two cubic centimeters of the undiluted drug proved fatal to birds in the first stages of infection. Fowls No. 215, 241 and 241A each given 1 cubic centimeter doses diluted with 2 cubic centimeters of distilled water recovered and were afterward proved to be immune. Gold chloride, "Gleb" Vorsccht, a 0.05 per cent solution of this drug was prepared in physiological saline solution and single injections of 2 cubic centimeter doses were given intravenously to nine fowls when at the height of the disease. Of this number, four recovered and were afterward proved to be immune. Introcid, a 10 per cent solution prepared in distilled water, was injected intravenously in 2 cubic centimeter doses, single injection. Of the two birds used, one died and the other recovered. Experiments with other percentage solutions and varying doses were unsuccessful. Fowler's solution given in large doses per orem was quite successful in field cases but not in artificially infected birds. Of five naturally infected birds treated, three completely recovered in about four weeks. The other two recovered from the acute attack, but later developed nervous derangements as manifested by

unsteadiness of the head and slight twitching of the neck, which disappeared in about 2 months after the birds were allowed to roam under field conditions. We gave three daily doses of 10 cubic centimeters each, followed by two daily doses of 5 cubic centimeters each after an interval of one day. The foregoing results while encouraging merely indicate the need for more extensive research along this line.

Curative effect of immune serum.—The success we had in neutralizing virus by means of small quantities of serum from immune fowls led us to investigate its curative value. The serum obtained from recovered animals was injected intravenously in 3 to 5 cubic centimeter doses, according to the size and age of the treated bird. Treatment was given when the symptoms began to appear, when at the height of the disease, and when the case was somewhat advanced. Our experiments show that when the serum is given early, when the disease is first visible in an animal, a cure is more certain. Failures may be due to impotent serum, old serum, or the administering of serum in the latter stages of the disease.

From our experiments, we conclude that fowls 4 to 6 months old need about three cubic centimeters, and full-grown chickens, about 5 cubic centimeters of potent serum given in one intravenous injection.

Of the 23 fowls treated with immune serum, regardless of the stage of the disease, 19 recovered and 4 died. Of the 19 that recovered, five developed nervous derangements or persistent inappetence which resulted in death due to inanition. Fourteen cases, therefore, completely recovered and were afterward proved to be immune. This makes about 60 per cent recovery from serum treatment.

The intramuscular and subcutaneous administration of serum is not effective in bringing about a cure.

Curative effect of organs from immune fowl.—An emulsion in distilled water of the testes, kidney and spleen of an immune rooster was injected intramuscularly in 5 cubic centimeter doses, single injection into four sick fowls at the height of the disease. The course of the disease was not modified by this treatment. Spleen emulsion alone was also tried on two sick chickens at the height of the disease using 1 cubic centimeter doses but without effect.

Curative effect of mammalian serum.—Although sheep serum seems to be able to render avian pest virus inert in vitro, when tried on a sick fowl, it did not effect a cure.

THE CONTROL OF FIELD OUTBREAKS

Since 1: 10000 aqueous solution of potassium permanganate kills the virus of avian pest in 40 minutes, we advocated potassium permanganate in drinking water in conjunction with 2 to 3 per cent aqueous solution of creolin to be used on the ground. Several infected poultry yards in Pasay, San Francisco del Monte, and San Juan in the Province of Rizal and in San Lazaro, Ermita, Paco, Santa Cruz, Singalong and Pandacan in the City of Manila, were benefited by the use of these agents. Wherever there was provision for isolation and whenever the disease had not yet infected the whole flock, good results were obtained.

As an example of a typical controlled outbreak, we give herewith data in connection with an infected Bureau poultry establishment located at Pandacan near the research laboratory. A flock of 61 chickens, 3 geese, 6 turkeys, and 15 ducks was infected in July, 1929, by the use of boxes that previously contained native chickens bought from a public market. When the disease among the Bureau chickens was discovered, 2 were dead, 3 showed visible symptoms of avian pest and others were in the prodromal stage. When the disease was diagnosed, confinement of the chickens was ordered. As there were 5 available pens, the flock was divided in 3 groups: (*a*) group of sick fowls, (*b*) group of suspicious cases, (*c*) group of well ones. The groups being separated by empty pens, had no means of communicating with each other. The ground and lower part of the fence and partitions were disinfected thoroughly every morning with 2 to 3 per cent creolin solution and the drinking water containing 1: 2000 potassium permanganate solution was renewed every day. Feeding was done in troughs previously disinfected with creolin solution. This procedure was rigidly followed under the direct supervision of the writer. There were in all 15 cases, of which 13 died and 2 recovered. The geese, ducks, and turkeys escaped infection.

The disease was checked in less than two weeks and since then no further casualty has been registered. No new cases occurred after the control procedures were begun. Those that were taken sick during the intensive control work contracted the infection before these measures were put into effect.

This method, which is described in detail, was recommended by the erstwhile Bureau of Agriculture in a lecture broadcasted by radio under the subject "A new avian disease in the Philip-

pines" on June 26, 1928, and published in Radio Lectures on Agricultural Topics, IV, Bureau of Agriculture, 1928.

The use of immune serum as a means of field control of the avian pest.—An opportunity to extend our experiments with immune serum was provided when Dr. Victor Buencamino, then a local practitioner, (now Assistant Director of this Bureau), called upon the Bureau for help in controlling field cases of avian pest. We treated in his veterinary hospital 1 very sick rooster (Rhode Island Red), 1 rooster just beginning to be sick and 4 hens well but exposed to infection. We used 5 cubic centimeters of immune serum for treating these big roosters and 3 cubic centimeters for prophylaxis in the case of the hen. The very sick rooster died, but the other rooster got well. The 4 hens did not develop the disease. Then another group composed of 8 Barred Plymouth Rock hens, all healthy but exposed to infection, were saved by the intravenous injection of 3 cubic centimeters of immune serum for each. Later, 7 full-grown Rhode Island Reds, belonging to Mrs. Aubrey, Santa Mesa, Manila were injected with 3 cubic centimeters each of immune serum given intravenously. This flock comprised 3 sick and 4 exposed birds. One of the 3 sick fowls recovered. Two of the 4 exposed birds remained well but the 2 others that received serum contracted the disease more than two weeks later. Apparently, these two fowls became infected from handling by the caretaker after the serum had been eliminated from the body.

Fifty chickens belonging to another owner were located in Santa Mesa near those of Mrs. Aubrey. For fear of the disease getting into his flock, the owner wished that we try immune serum as a prophylactic agent. We consented to try the serum. When these chickens were visited, one was already sick, so it was given 5 cubic centimeters of immune serum intravenously. It recovered. Then 12 hens and 1 rooster were given each 3 cubic centimeters of immune serum intravenously. Of these 1 hen and 4 of those without serum became infected. Then a set of 25 hens and 5 roosters were given serum 3 cubic centimeters each and 5 cubic centimeters each for two sick hens. One of these sick hens recovered from serum treatment. In all, 46 fowls were injected, only 4 receiving no injection. As a whole 21 became sick, 2 recovered, 19 died and 31 were left. It seems that immune serum has but little merit as a prophylactic agent.

The laboratory results of passive immunization with avian pest serum was not even as good as that of our field experiments. Out of 8 fowls injected with ½ to 2 cubic centimeters of serum by the intravenous route followed 1 day later with subcutaneous dose of 125 minimum infection doses with 2 controls, only 1 escaped infection and another had a delayed reaction, recovered and was immune. It is probable that 3 cubic centimeters in field cases may be enough to protect an individual from minute amounts of virus taken by chance, while 125 minimum infection doses given subcutaneously may be too much for ½ to 2 cubic centimeters of immune serum given 1 day earlier. The two controls became sick and died in a typical manner.

VACCINATION AS A PROPHYLACTIC

At the first attempts to control field outbreaks, part of our efforts were directed to discovering a vaccine that would raise resistance to or even confer immunity to healthy animals against the attack of this pest.

The success that resulted in the employment of chloroform in the preparation of rinderpest vaccine gave us the idea of using chloroform to treat organs of fowls that were killed at the height of the disease or fowls that were about to die from the disease. The liver, spleen, lungs, kidneys, and brains were grouped and emulsified in physiological saline and chloroform was added to make a product containing 0.75 per cent of chloroform. This preparation was used after storage of from one day to one month in the ice-chest (0°–4° C.) and in doses of varying number and quantity. The intervals of doses ranged from 4 days to 9 days, ½ to 1 cubic centimeter of virulent virus being given subcutaneously 4 to 14 days after the last dose of vaccine. Out of 9 fowls vaccinated with this vaccine, only 1 remained well and immune to subsequent virus, 2 became sick and recovered, and 6 died either from the vaccine or from virus given later.

A vaccine made of 20 cubic centimeters of 50–50 tissue and saline emulsion with 0.15 cubic centimeter chloroform and 1 cubic centimeter of 10 per cent phenol stored for 1 day in the ice-chest (0°–4° C.) caused avian pest. (See Tissue Vaccine No. III.)

A 50–50 glycerine-water vaccine kept 5 months and 11 days in ice-chest (0°–4° C.) injected in 1 cubic centimeter single dose subcutaneously into Fowls 254 and 255 did not confer immunity.

Tissue Vaccine No. 1 was composed of a ground tissue (spleen, liver, kidneys) emulsion in physiological saline and filtered through gauze. To 20 cubic centimeters of this filtered material 10 cubic centimeters of Colgate's glycerine was added and the mixture stored in a cotton-stoppered bottle in the ice-chest (0°–4° C.) for 21 days. It was given subcutaneously in 1 cubic centimeter dose single injection to Fowls Nos. 149 and 150. Fowl 149 became sick and died from the vaccine; Fowl 150 contracted the infection and died from virus inoculated 8 days later.

Tissue Vaccine No. II was made in a manner similar to No. I except that 0.5 per cent phenol was used instead of glycerine. This vaccine was stored in the ice-chest for 21 days. It was given in 1 cubic centimeter and 2 cubic centimeter doses at 16 days intervals to Fowl No. 151 and in 1 cubic centimeter single dose to Fowl No. 152. Fowl No. 151 remained well and was immune when virus was given 14 days after the vaccine; Fowl No. 152 became sick and died from virus given 8 days after the vaccine.

Tissue Vaccine No. III was composed of 10 grams of strained tissue in 10 cubic centimeters of physiological saline with 0.15 cubic centimeter chloroform and 1 cubic centimeter of 10 per cent phenol and stored for 21 days in ice-chest (0°–4° C.). This vaccine was injected subcutaneously in 1 cubic centimeter dose to Fowl No. 152. Ten days later 2 cubic centimeters of Tissue Vaccine No. I was given in like manner. The animal became sick and died from paralysis. Tissue Vaccine No. III, given in 2 cubic centimeter subcutaneous dose to Fowl No. 154 did not protect the bird from an injection of virus 7 days after the vaccination.

Tissue Vaccine No. IV was composed of 20 cubic centimeters of ground organs emulsified in physiological saline with 1 cubic centimeter of toluol. This vaccine was given subcutaneously in 2 injections after 21 days storage in ice-chest (0°–4° C.) in doses of 1 cubic centimeter and 2 cubic centimeters after an interval of 10 days into Fowl No. 155 and in 1 cubic centimeter subcutaneous single injection to Fowl No. 156. Fowl No. 155 became sick and died from the vaccine. Fowl No. 156 became sick and died from a subsequent injection of virus.

Control Fowls No. 148, 159, 160, and 162 became sick and died from virus injection.

Immunization with phenol glycerine vaccine (Todd's method).—The success of Todd(7) in producing a fowl plague vac-

cine which gave a solid immunity to fowls vaccinated with a phenol glycerine vaccine suggested the trial of a similar preparation in the case of avian pest. Instead of using the liver alone we used the brain, kidney, and spleen in addition, as these tissues were found to contain virus in a virulent state.

To every gram of tissue we added 6 grams of the following solution as prepared by Todd(7):

Phenol	gram....	0.5
Glycerine	cubic centimeters....	60.0
Distilled water	do........	39.5

The organs were first reduced to a paste in a mortar by employing silica. Then the glycerine phenol solution was added in the proportion mentioned above. The resulting emulsion was placed in a stoppered bottle and kept in an ice-box at a temperature ranging from 18 to 22° C. This was allowed to stay for seven days and then removed into the ice-chest (0°–4° C.) ready for use.

The first set of chickens received doses in the following manner:

Fowl No.	Route	Dose of vaccine	Interval of doses	Tested after	Results
			Week	*Days*	
338	Intramuscular	½ cc. 1 cc. 3 cc.	1	14	Became sick and recovered but died from paralysis.
339	do.	½ cc. 1 cc. 3 cc.	1	14	Do.
340	do.	½ cc. 1 cc. 2 cc.	1	14	Became sick and died from virus.
348	do.	½ cc. 1 cc. 1½ cc.	1	....	Became sick and died from vaccine.
363	do.	½ cc. 1 cc. 3 cc.	1	10	Became sick and died.
364	do.	½ cc. 1 cc. 3 cc.	1	10	Became sick and died.
365	do.	½ cc. 1 cc. 3 cc.	1	10	No effect; immunized.
366	do.	½ cc. 1 cc. 3 cc.	1	10	Became sick and died.
352	do.	Control	....	....	Became sick and died from virus.
367	do.	5 cc.	....	....	Became sick and died from pox and roup.
368	do.	2½ cc. 2½ cc.	1	10	Became sick and died.
373	do.	5 cc.	....	17	Became sick and died.
374	do.	2½ cc. 2½ cc.	1	10	Became sick and died.
375	do.	5 cc.	....	17	Became sick and died.
377	....	Breed control	....	....	Became sick and died.
378	....	do.	....	....	Became sick and died.
379	....	Virus control	....	....	Became sick and died.

A better result was obtained in a second series of experiments using organs obtained from animals that were at the height of acute attacks. The preparation was done in exactly the same way as that of the first series but given in ½, 1, and 3 cubic centimeter intramuscular doses at 1-week intervals followed by 1 cubic centimeter of avian pest virus 8 days after the last injection of vaccine. Of the 6 fowls vaccinated, 3 became sick and died, while 3 had mild attacks, recovered and were immune. All three controls became sick and died with good lesions.

While hope is entertained as to the possibility of modifying the technique in the preparation of avian pest vaccine, the outcome of these trials merely indicates a basis for further experimentation.

Virus vaccine.—The crop contents of a sick fowl is found to be very rich in virus, as one cubic centimeter of a very highly diluted crop content is capable of producing the disease. We therefore attempted to produce a vaccine from the crop content. The following mixture was made:

	Per cent
M/15 Sorensen's potassium phosphate	25
M/15 Sorensen's sodium phosphate	25
Liquid virus (crop content)	49
Carbolic acid	1

This mixture was placed in a 100-cubic centimeter graduated cylinder and shaken 100 times to insure a thorough mixture. Then it was set aside in the Frigidaire for 24 hours. An equal amount of distilled water was added to make the product 0.5 per cent phenol. The phenol was added to attenuate the virus, and the phosphates were intended to sustain the viability of the organism.

This vaccine was used on Fowls No. 410, 411, 412, 413, and 414 immediately after preparation with 1 cubic centimeter as an initial dose and 3 cubic centimeters injected 1 week later. Fowl 411 became sick 6 days after the second dose, and Fowls 412 and 414 died from the first dose. Fowls 410 and 413 died from virus given 10 days after the second injection. In these two cases it may be that the fowls were still in the incubation period when the virus was given. In view of these results we conclude that 1 per cent phenol does not sufficiently attenuate the virus in 1 day when placed in the Frigidaire at 2°–3° C. to justify its use in vaccine manufacture.

This virus vaccine was again, 7 days after preparation, tried on Fowls 420, 421, 422. Fowl 420 received ½ cubic centimeter and 2½ cubic centimeters at 1-week intervals; Fowl 421 received ½ cubic centimeter, 2½ cubic centimeters, and 4 cubic centimeters and then revaccinated with 1 cubic centimeter, 2 cubic centimeters, and 3 cubic centimeters of chloroform killed vaccine; Fowl 422 received ½ cubic centimeter, 2½ cubic centimeters, and 5 cubic centimeters at 1-week intervals. When these three fowls received ½ cubic centimeter dilute virus fourteen days after the last dose of vaccine, every one died from the infection.

It appears that this material has no value in the production of vaccine, as it is infective when newly prepared, and becomes innocuous one week after preparation.

Tissue vaccine.—The following solution

	Cubic centimeters
Distilled water	49
Glycerine	49
Phenol	2

was added to 30 grams of tissue (spleen, liver, kidneys) made into a paste with silica. This emulsion was passed through 4 layers of gauze and placed in the Frigidaire (2°–3° C.) for 18½ hours. Then one part of this vaccine was added to 3 parts of the following solution:

	Parts
M/15 Sorensen's potassium phosphate	100
M/15 Sorensen's sodium phosphate	100
Distilled water	200
Total	400

The vaccine thus prepared was 0.5 per cent phenol and 24.5 per cent glycerine.

This vaccine was tried on Fowls 415, 417, 418, and 419 with ½, 2, and 4 cubic centimeters of intramuscular doses. Fowl 415 became sick from the first dose (½ cubic centimeter), recovered and was immune. Fowl 418 receiving ½ cubic centimeter, 2 cubic centimeters, and 4 cubic centimeters and Fowl 419 receiving ½ cubic centimeter and 2 cubic centimeters vaccine intramuscularly contracted the infection. Fowl 417 receiving ½ cubic centimeter, 2 cubic centimeters, and 4 cubic centimeters phenolized tissue vaccine and also 1 cubic centimeter and 2 cubic centimeters chloroform killed vaccine resisted artificial infection.

Brain and spleen phenol killed vaccine.—Brains and spleens of birds at the point of death were collected and weighed. These were easily ground in a mortar without the aid of silica. Little by little a 1 per cent phenol-saline solution was added until the product was 8 parts tissue to 100 parts of the emulsion. The emulsion was then placed in a graduated cylinder of 50 cubic centimeters capacity and then in the incubator for 18 hours. Then an equal amount of physiological saline was added to make the product ½ per cent phenol, after which it was stored in the Frigidaire.

This vaccine was used in single intramuscular injections of 3 cubic centimeters into Fowls 429 and 430 and in 3-cubic centimeter and 5-cubic centimeter doses at 14 days interval to Fowls 431 and 432. Fowls 429 and 430 succumbed to ½ cubic centimeter virus given 14 days after the injection of vaccine; Fowl 431, despite a subsequent 2-cubic centimeter dose of chloroform killed vaccine became sick and died after a long illness from ½ cubic centimeter of virus in 14 days after the last dose of vaccine. Fowl 432 contracted the infection and died from the second dose of virus. Control Fowls 433 and 436 became sick and died from a ½-cubic centimeter dose of virus.

The successful results obtained with rabies vaccine by the application of the above method does not seem to apply in the case of avian pest. There is no doubt that the brain and spleen are virulent organs, but they prove to be valueless when made into a vaccine by this method.

Chloroform killed virus in spleen and brain.—The use of chloroform in the preparation of rinderpest and rabies vaccines according to Kelser(9) were most gratifying in their results. We therefore endeavored to ascertain whether or not results would be equally satisfactory with a vaccine for avian pest made in a similar manner.

Seven grams of brain and spleen were reduced to a paste. Then 14 cubic centimeters of distilled water was slowly added with constant stirring. The resulting even emulsion was next strained through 4 layers of gauze. The loss in straining was made up by adding distilled water to make 21 cubic centimeters. Then 0.1575 of chloroform was added to make the emulsion 0.75 per cent chloroform. The preparation was kept in the Frigidaire (2°–3° C.) for 24 hours, after which 21 cubic centimeters of distilled water was added to make 0.37½ per cent chloroform. This preparation constituted the vaccine.

Fowls 417 and 421 were given 1-cubic centimeter and 2-cubic centimeter intramuscular doses at 1-week intervals followed by ½ cubic centimeter virus 15 days after the second dose. Both of these became sick and died from the virus injection. Fowls 431 and 434 received 2-cubic centimeter and 3-cubic centimeter intramuscular doses given at intervals of one week. Fowl 431 became sick from virus given 15 days after second dose of vaccine and died from general debility after 12 days of illness. Fowl 434 remained well and was immune. Fowls 437 and 438 received 1-cubic centimeter and 3-cubic centimeter vaccine at intervals of 14 days. Fowl 438 became sick 13 days after the second dose; Fowl 437 remained well and resisted ½-cubic centimeter virus given 15 days after the second dose. Control fowls 433 and 436 each given ½ cubic centimeter of diluted virus succumbed to avian pest.

Tricresol-killed vaccine.—Nine spleens were taken from sick fowls and dried for seven days in the Frigidaire, and then ground, strained and emulsified in 50 cubic centimeters of distilled water. To the useful portion, enough tricresol to make 1 per cent was added; this mixture was thoroughly shaken and then kept for 18 hours in the Frigidaire, after which an equal amount of distilled water was added to make the final product ½ per cent tricresol. This vaccine was used in 3-cubic centimeter single doses given intramuscularly. Results were unsuccessful.

Chloroform treated spleen.—A portion of the emulsion of dried spleens used in the preparation of tricresol-killed vaccine was treated with 0.75 per cent chloroform and placed in the Frigidaire for 41 hours. This product was diluted with an equal amount of distilled water before use. Results were unsuccessful in two test fowls, each being given 3-cubic centimeter doses, single injection.

Vaccination with centrifuged virus.—Virus suspension in a solution of sodium and potassium phosphate of pH 7.2 was centrifuged on the International Centrifuge (Load—156 grams, adjustment No. 9) for one hour. One cubic centimeter of the supernatant fluid was injected subcutaneously into two fowls. Both of these died with typical symptoms and lesions, showing that the virus cannot be attenuated in this manner at the speed and for the time in which trial was made.

Vaccination with virus treated with N/1 HCl.—Ten cubic centimeters of virus suspension of pH 8.2 was mixed with 0.6 cubic centimeter of N/1 HCl. The resulting H-ion concentra-

tion was pH 7. This was allowed to stay in the Frigidaire for 18 hours with occasional shaking. Two cubic centimeters of this mixture was injected into each of 2 fowls. Both of these became sick and died.

Ten cubic centimeters of a virus suspension of pH 8.2 was rendered acid (pH 6.6) by adding 0.6 cubic centimeter of N/1 HCl. This mixture was kept in the Frigidaire for 12 days. No change of reaction was noted. Two cubic centimeters of this mixture we injected into each of 2 fowls. Both of them became sick and died. Two other fowls each injected in the wattles with 1 cubic centimeter doses succumbed in the usual manner.

Phenol, glycerine, toluol, chloroform, tricresol, and hydrochloric acid were the only chemicals so far tried and although the appropriate proportions have not been discovered, other drugs like ether and formol will also be tried. Not one of the formulae put to a test was uniform in its results. So we cannot at the present writing claim any success in producing a vaccine of any merit. The preparation made according to Todd's method and the chloroform-killed vaccine made from spleen and brain were so far the most encouraging of those that were tested.

DISCUSSION

The question as to whether or not some birds possess a natural immunity to this disease cannot be answered in this paper. In the pursuance of our investigation thus far, we found two cases which did not become sick from virus proved to be virulent in other birds. When retested these birds showed a solid immunity to the disease. As these chickens were only about three and a half months old, the chance of their having recovered from a former infection was slight, as these fowls were secured from places where the disease had not been present for two years previous to purchase.

With regard to the differential diagnosis of this malady, it appears to be an established fact that this new disease of birds to which we have given the name "avian pest" is identical with the Newcastle disease of England, pseudo-fowlpest of Java and Ranikhet disease of India. While it possesses several points of similarity to European fowl pest, the results of cross-immunity tests performed by Doyle(1) and Picard(2), the marked difference of infectivity of the blood in high dilutions, as well as differences in course and sequelae, demonstrate that the two diseases are separate entities. Pappenheimer has shown that fowl paralysis, reported by Pappenheimer, Cone and Dunn(3),

manifests itself in a different pathological histology nerve picture. No difficulty in differential diagnosis is offered by infectious bronchitis, infectious roup, coccidiosis and some of the parasitic diseases, although they have some symptoms in common with avian pest.

The clinical manifestation observed by us which was not mentioned in the papers of Doyle(1) and Picard(2) is the opacity (moon-blindness) of the cornea. Moreover, these independent workers divide the course of the disease into acute, subacute and chronic, and consider that paralysis is a stage of the disease. We are more inclined to believe that the nervous troubles are but sequelae of nerve injury during the attack which is always acute. Nervous troubles are seen in recovered birds.

The value of recovered fowls depends upon the injury sustained by them. Most of those that regain their appetite return to normal in every respect, lay eggs and breed. The fowls which do not return to normal die within one to two months.

Regarding immunization, Doyle(1) using heat-killed virus and formalized virus was only able to produce a suggestive increase in resistance in vaccinated fowls. Doyle tried the value of immune serum and obtained in one fowl resistance to natural infection but not to artificial infection by the use of a subcutaneous injection of hyperimmune serum. Picard(2) attempted to protect fowls by the use of immune serum, but his results only indicated the acquisition of a certain resistance by prolonging the course of the disease in injected birds. Our results from vaccination were not much more fruitful, although we succeeded in producing some cures with the intravenous injection in the axillary vein of from 3 to 5 cubic centimeters of potent serum. We also produced passive immunization in several instances by the intravenous injection of 3 cubic centimeters of immune serum. The field application of this method however is not advisable, as we can only obtain about 25 cubic centimeters of serum from an ordinary mature native fowl.

Of the chemicals tried for their therapeutic value, only Fowler's solution gave encouraging results. However, as individual medication is necessary when using this drug, its use would not be practical except in the treatment of valuable birds.

CONCLUSIONS

1. Progress in the investigation of a hitherto unknown disease of the avian family in the Philippine Islands, for which we proposed the name of avian pest, is herewith reported.

2. This disease is caused by a filter-passing virus, and may be described as an acute, febrile, infectious disease characterized by dyspnea, diarrhea, and inappetence, with nerve injury which is manifested by various locomotor disturbances in birds that survive the acute attack. .

3. This disease is identical with the Newcastle disease of England, pseudo-fowlpest in Java and Ranikhet disease in India.

4. The average incubation period of artificial infection is 4 to 5 days; the average course of the disease is 2 to 4 days after the symptoms have appeared.

5. The mortality in newly infected flocks ranges from 10 to 100 per cent.

6. Natural infection is brought about by the ingestion of virus through food or water.

7. Artificial infection can be produced by introducing the virus by the mouth, under the skin, into the muscles, into the blood vessels, intraocularly, in the conjunctiva and by the cloaca, but not by means of sexual contact or scarification.

8. The virus does not affect mammals.

9. The virus is found in the spleen, kidneys, ovaries, testes, liver, lungs, crop, saliva, intestines and brain, very rarely in the blood and the feces, and not in the gelatinous infiltration at the thoracic inlet.

10. Fifty degrees Centigrade to 55° C. for 30 minutes kills the virus.

11. Direct sunlight kills the virus in one hour exposure.

12. A 1: 10000 aqueous solution of potassium permanganate inactivates the virus in 40 minutes.

13. Sheep serum has a neutralizing effect on the virus of avian pest in vitro.

14. Immune serum (1½-cubic centimeter serum to 125 minimum infective doses) has a neutralizing effect on virus.

15. The minimum infective dose of the virus (minimum infective doses) was 1 cubic centimeter of a dilution of 1 to 1,250 of saliva.

16. The virus of avian pest as determined by cataphoresis is negatively charged.

17. The virus is not thrown down by centrifugation.

18. Virus can be kept viable in the ice-chest for at least 10 months and 20 days; at room temperature virus in the liquid form remained active for 15 days. Virus in garden soil and in stagnant water placed in a room where diffuse sunlight en-

tered through rough glass was inactivated in 4 days. Active virus can be obtained from a bird 168 hours after death.

19. The cross-immunity tests performed independently by Doctors Doyle, Picard, and Cooper and those by us were unanimous in results.

20. The treatment of artificial infection by the use of drugs has so far been quite unsuccessful. The result of individual treatment with Fowler's solution naturally injected is encouraging if given early.

21. Treatment by the use of immune serum injected intravenously was partially successful.

22. The employment of immune serum as a field control measure was unsatisfactory.

23. The control of outbreaks by means of chemicals has been successful in well equipped poultry yards.

24. Attempts to produce a vaccine of prophylactic or therapeutic value have failed. The few good results could not be repeated.

25. Diagnosis by complement fixation was not successful.

ACKNOWLEDGMENT

The writer is indebted to Dr. E. A. Rodier, Pathologist and Chief, Veterinary Research Division, Bureau of Animal Industry, for the many valuable suggestions and help given by him during the pursuance of this work.

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TABLE 1.—*Avian pest: Diagnosis by complement fixation*

Tube No.	Antigen dilution ½ cubic centimeter	Positive serum 1:10	Complement 1½ units		Hemolysin 2 units	Corpuscles 2 per cent		Results: Ethylic extract of dry organs	Results: Ethylic hot extract of fresh liver	Results: Methylic extract of dry organs	Results: Saline extract of spleen	Results: Brain emulsion in saline	Results: Liquid virus PH7.2
1	1:20	5/10 cc.	1 cc.	Fifteen hours in ice-box.	6/10 cc.	5/10 cc.	One hour at 37°C., 2 hours at room.	C. H.	C. H.	C. H.	C. H.	C. H.	C. H.
2	1:40	do.	1 cc.		6/10 cc.	5/10 cc.		C. H.	C. H.	C. H.	C. H.	C. H.	C. H.
3	1:80	do.	1 cc.		6/10 cc.	5/10 cc.		C. H.	C. H.	C. H.	C. H.	C. H.	C. H.
4	1:160	do	1 cc.		6/10 cc.	5/10 cc.		C. H.	C. H.	C. H.	C. H.	C. H.	C. H.
5	1:20	5/10 cc. saline.	1 cc.		6/10 cc.	5/10 cc.		C. H.	C. H.	C. H.	C. H.	C. H.	C. H.
6	5/10 cc. saline.	5/10 cc. positive serum.	1 cc.		6/10 cc.	5/10 cc.		C. H.	C. H.	C. H.	C. H.	C. H.	C. H.
7	1:20	5/10 cc. negative serum	1 cc.		6/10 cc.	5/10 cc.		C. H.	C. H.	C. H.	C. H.	C. H.	C. H.
8	½ cc. saline.	5/10 cc. saline.	1 cc.		6/10 cc.	5/10 cc.		C. H.	C. H.	C. H.	C. H.	C. H.	C. H.
9	do.	do.	1 cc. saline.		6/10cc. saline.	5/10 cc.		N. H.	N. H.	N. H.	N. H.	N. H.	N. H.
10	do.	do.	do.		6/10 cc.	5/10 cc.		N. H.	N. H.	N. H.	N. H.	N. H.	N. H.

C. H.=Complete hemolysis; N. H.=No hemolysis.

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TABLE 2.—*Routes of infection*

Fowl No.	Virus used	Dose	Route	No. of trials in one fowl	Success		Result after giving virus in ordinary route
					Positive	Negative	
321	Pooled crop contents concentrated.	1 drop	Conjunctiva by dropping	2		Negative	Became sick and died. Good lesions.
322	do	3 drops	Into the cloaca by dropping.	2		do	Do.
323	do	do	Scarification on comb	2		do	Do.
324 [a]	do	½ cc. diluted 1:10	Subcutaneous	1	Positive		Became sick and died. Good lesions.
325	Crop contents filtered	1/10 cc	Intraocular	1	do		Remark: Moonblindness 1 first day. Animal appeared as if rabid, defective locomotion, cloudy cornea. Died.
326	Crop contents pooled	½ cc. of diluted crop content 1:10.	Subcutaneous	1	do		Became sick and died. Had paralysis of both legs.
333	Filtered crop contents and organ emulsion.	1 drop ½ cc	Conjunctiva dropping	1		Negative	Became sick and died from ½ cc. virulent virus intramuscular.
333	Organ emulsion	½ cc	Intramuscularly	1	Positive		Do.
334	Concentrated crop content and organ emulsion.	3 drops	Scarification of comb	2		Negative	Became sick and died from fresh virus.
335	Concentrated crop content	½ cc	By cloaca	1		do	Became sick and died.
335 [b]	Pooled crop content	do	do	1	Positive		Typical lesions and symptoms.

[a] Control to virus.

[b] Repeated.

TABLE 3.—*Transmission by contact*

Fowl No.	Number of days of contact	Number of sick fowls	Results	Remarks
71	11	2	Became sick and died	Typical symptoms and good lesions.
86	9	[a] 2	Became sick and died despite treatment with salvarsan	Do.
87	7	2	Became sick and died despite treatment with clenzal daily since beginning of contact	Do.
90	6	2	Became sick despite daily oral dose of 2½ per cent clenzal 15 cc. and died despite salvarsan treatment.	Do.
100	10	2	Became sick and killed for vaccine	Do.
122	8	3	Became sick and died	Do.
377	6	3	Became sick and died despite treatment	Do.
378	9	3	Became sick and died despite treatment	Do.
266	6	3	Became sick and died	Good lesions.

[a] One artificial and one field case.

TABLE 4.—*Filtration experiments*

Fowl No.	Make of filter	Dose	Material	Route	Result
		cc.			
24	Berkefeldt "V" candle		Cotton filtrate of intestinal scraping emulsion.	Subcutaneous	Became sick and died. Good lesions.
31	Berkefeldt "W" candle	2	do	do	Do.
35	Berkefeldt "W" candle	2	do	do	Became sick. Protracted case; died from severe emaciation.
37	do	2	do	do	O. K. in 30 days. Became sick and died after virulent material.
39	Berkefeldt "V" candle	2	Crop contents	do	Became sick and died; good lesions.
40	do	2	Laked blood	do	No effect. Became sick and died with virulent material.
41	Berkefeldt "W" candle	2	Emulsion of proventriculus and intestines.	do	No effect in 36 days. Given unfiltered virus. Became sick and died in 7 days.
48	Berkefeldt "V" candle	2	Crop contents intestine scraping esophageal emulsion.	do	Became sick but recovered; emaciated; ultimately died from cachexia.
50	Berkefeldt "W" 24	2	Filtrate of above, 24 hours at room temperature.	do	Became sick and died. Good lesions.
56	Berkefeldt "W" candle	10	Crop content and intestine scrapings.	do	Do.

TABLE 4.—*Filtration experiments*—Continued

Fowl No.	Make of filter	Dose	Material	Route	Result
		cc.			
58	Berkefeldt "W" after passing Berkefeldt "V."	10	Crop content and intestine scrapings.	Subcutaneous	Became apparently sick and recovered. Injected 10 cc. Berkefeldt "W." Crop content of several chickens. Became sick and died.
58	Berkefeldt "W" after passing Berkefeldt "V."	10	Crop content	do	Became apparently sick. Recovered.
58	Berkefeldt "W"	10	do	do	Became sick and died.
57	Berkefeldt "V"	5	Crop content, intestine scrapings.	do	Became sick and recovered.
57 (later)		10	Crop content of sick fowls	Fed	No reaction.
59	Berkefeldt "W" after passing Berkefeldt "V."	10	Crop content	Subcutaneous	Became apparently sick and recovered.
59 (again)	Berkefeldt "W"	10	do	do	Became sick and died.
64	Berkefeldt "W" of 43 and 49, 79, 83, 80.	10	do	do	Became sick and recovered.
64 (again)		([a]) 3	do	Per orem	No reaction.
66	Berkefeldt "W" of 54 and 55	10	do	Subcutaneous	Became sick and died in 6 days. Good lesions.
73	Berkefeldt "V"	10	do	do	Became sick and died in 8 days.
78	Berkefeldt "W"	5	do	do	Became sick and died in 7 days.
79	do	5	do	do	Became sick and died in 11 days.
81	Berkefeldt "W"	10	do	do	Became sick and died in 7 days.
82	do	10	do	do	Became sick and recovered after 25 days.
83	Control not filtered crop content.	7½	Dilute crop contents	do	Became sick and died in 8 days.
91	Berkefeldt "W"	10	do	do	Became sick and died despite treatment with salvarsan.
92	do	10	do	do	Became sick and died. No treatment.
93	do	10	do	do	Became sick and died despite treatment with salvarsan.
94	do	10	do	do	Do.
108	do	10	Crop content 1 day old at room temperature.	do	Became sick and died on 7th day.

[a] Total dose is 3 cubic centimeters and 10 drops.

TABLE 5.—*Virulence of tissues*

Fowl No.	Tissue	Nature of tissue	Dose	Route	Results
21	Intestinal mucosa	Fresh emulsion of scraping	1 cc.	Subcutaneous	Became sick and died. Good lesions. Typical symptoms.
22	do.	do.	1 cc.	do.	Became sick and recovered. Tested with virus; immunized.
23	do.	do.	1 cc.	do.	Became sick and died. Good lesions; typical symptoms.
28	Mucosa of proventriculus and rectum.	do.	1 cc.	do.	Became sick and died. Good lesions.
33	Mucosa of rectum, field case	do.	1 cc.	do.	Became sick, but not typical, probably died from catarrh.
34	Rectal mucosa, Fowl 24	do.	1 cc.	do.	Became sick and died. Typical symptoms and lesions.
35	Blood	Laked Berkefeldt "W" filtrate	2 cc.	do.	Became sick and died. Good lesions.
38	Proventriculus and rectal mucosa.	Fresh emulsion of scraping	1 cc.	do.	Do.
40	Blood	Laked blood Berkefeldt "V"	2 cc.	do.	No effect. But got sick and died 7 days after giving virus.
43	Intestine scraping	Emulsion in distilled water	1 cc.	do.	No effect. Given virus San Pedro Tunasan; got sick and died. Lesions good.
45	Crop content	Emulsion	5 cc.	do.	Became sick and died third day. Lesions characteristic.
46	Crop, intestine and esophagus scraping.	Emulsion in distilled water	5 cc.	do.	Became sick and died.
47	do.	do.	5 cc.	do.	Became sick and recovered. Injected and fed virus 2 times. Remained well. Immunized.
49	Crop content	do.	8 cc.	Per orem	Became sick and died. Good lesions.
52	do.	do.	10 cc.	do.	Became sick and recovered. Fed organs. Got sick and recovered. Injected 5 cc. crop contents of several birds. Fed again crop contents of several fowls.
53	do.	do.	10 cc.	do.	Became sick; treated with 1/25 gram salvarsan. No effect; died; good lesions.
54	do.	do.	10 cc.	do.	Became sick and died. Good lesions.
55	Intestine, crop and esophagus scraping.	do.	5 cc.	Subcutaneous	Became sick and developed paralysis. Killed at agonal stage. Emaciated.
60	Feces of 43 and 49	do.	20 cc.	Per orem	No effect. Got crop content. Got sick and died.
61	do.	do.	20 cc.	do.	Do.
62	Rice plus feces of 54 and 59	do.	Handful	do.	Became sick and died from fresh virus.
63	do.	do.	do.	do.	Do.

TABLE 5.—*Virulence of tissues*—Continued

Fowl No.	Tissue	Nature of tissue	Dose	Route	Results
65	Blood	5/100 per cent phenol	3 cc.	Subcutaneous	No effect.
67	Crop content	In water	Allowed in drinking water.	Per orem natural drinking.	Became sick and died in seven days. Good lesions.
68	do	do	do	do	Do.
69	Rice plus feces	Mixture with rice	Allowed to eat 1 handful.	do	No effect.
69	Crop content	Emulsion in water	5 cc.	do	Became sick and died n 5 days.
70	Rice and feces. Same as 69	Mixture of feces and rice	Allowed to eat a handful.	do	No effect.
70	Crop content	Emulsion in water	4½ cc.	do	Became sick and died in 5 days.
72	Blood	Whole	Few drops	do	No effect.
72	Crop content	A few cc. of crop content in water	Ad libitum	do	Became sick and died.
74	do	Whole	1 cc.	Subcutaneous	Became sick and died within 8 days
75	do	do	4 cc.	Per orem	Became sick and died within 5 days.
76	do	do	4 cc.	Subcutaneous	Died in 2 days.
77	do	do	4 cc.	do	Do.
81	Blood from hearts of dead fowls 76, 77, 67.	Whole blood	1 cc.	do	No effect
84	From fowl 75; liquid infiltration at point of inoculation.	Whole	2 cc.	do	Died next day. No apparent lesions. Poison (?).
85	Same as 84	Whole liquid infiltration	2 cc.	do	No effect in 7 days.
85	Crop content	Diluted in water	5 cc.	Per orem	Became sick and died with typical symptoms and good lesions.
88	do	do	3 cc.	do	Became sick and died in 5 days.
89	do	do	3 cc.	do	Became sick and died in 7 days.
95	do	do	4 cc.	do	Became sick and died.
116	Feces	Whole	3 cc.	do	No effect.
116	Crop content	Diluted in water	3 cc.	do	Became sick and died.
117	Blood whole	Whole direct from vein of sick bird F. 100.	2 cc.	Subcutaneous	No effect.
117	Blood	Phenolized 5/10 per cent from 129 and 192–A.	2 cc.	do	Do
118	do	Whole duct from vein	1 cc.	do	Do.
118	do	5 per cent phenolized 129 and 129–A.	2 cc.	do	Do.
123	Crop content 129 and 129–A	Diluted in water 15 days in ice box.	½ cc.	do	No effect. Injected with mixed virus. Became sick and recovered.
125	Blood	5/10 per cent phenolized blood	2 cc.	do	No effect.
130	Crop content 129 and 129–A; control to virus used.	Diluted in water. Control	2½ cc.	do	Became sick and died.
161	Blood	Defibrinated blood	1½ cc.	Intravenous	Became sick but recovered.
163	Spleen	Emulsion in distilled water	1 cc.	Subcutaneous	Became sick and died despite treatment.
164	Kidney	do	1 cc.	do	Became sick and died.
165	Brain	do	1 cc.	do	Became sick and died despite treatment

166	do	do	1 cc.	do	Became sick and died.
167	Lung	do	1 cc.	do	Became sick and died despite treatment.
168	Ovaries	do	1 cc.	do	Became sick and died despite treatment after a long illness.
169	Liver	do	1 cc.	do	Became sick but recovered.
170	Testes	do	1 cc.	do	Became sick and died on the 7th day.
210	Blood from Fowls 185, 189, 190	Citrated 5/10 per cent	1 cc.	Intravenous	Do.
211	do	do	1 cc.	do	Became sick and killed for blood.
212	Serum from sick birds 185, 65, 158.	Separated from clot by centrifuge.	1 cc.	do	No effect, but succumbed to 125 M.I.D. virus.
213-A	Serum from sick bird 185, 189, 190.	Separated from citrated blood by centrifuge.	1½ cc.	do	No effect. 125 M.I.D. virus. No effect. 500 M.I.D. No effect.
213	do	do	1½ cc.	do	No effect. Became sick from 125 M.I.D. but recovered from immune serum.
214	Washed red cells	Red cells in saline 50/50 washed 4 times.	2 cc.	do	No effect. Became sick and died from 250 M.I.D.
215	do	do	1½ cc.	do	No effect. Became sick from 250 M.I.D. Recovered.
233	Serum from sick birds	Separated from dif. blood by centrifuge.	1½ cc.	do	No effect.
234	do	do	1½ cc.	do	Do.
269	Blood from 2 sick birds	Whole blood after drawing	1½ cc.	do	Became sick and died.
270	do	do	1½ cc.	do	Do.
293	Feces	Emulsion in distilled water	1 gm.	Per orem	No effect.
294	do	do	2 cc.	Subcutaneous	Do.
305	do	Watery feces mixed with rice	Handful of mixture	Per orem	Became sick and recovered rom m-mune serum.
117	Blood	Direct transfusion	2 cc.	Intravenous	Became sick and recovered.
212-A	Serum from clot (sick birds)	Pooled whole serum	1 cc.	Subcutaneous	Had slight reaction.

TABLE 6.—*Thermolability of virus*

Fowl No.	Nature of virus	Temperature to which subjected	Time of exposure	Dose	Route	Results
				cc.		
136	Cotton filtered crop content. Fowls 129 and 192–A.	100° C	5 minutes	1	Subcutaneous	Heated virus, no effect. Fowl became sick and recovered from fresh virus. Immune to a subsequent fresh virus.
137	do	70° C	30 minutes	1	do	Heated virus; no effect. Became sick and died from fresh virus.
138	do	70° C	10 minutes	1	do	Heated virus; no effect. Became sick and died from fresh virus.
139	do	Control not heated	Control	1	do	Became sick and recovered. Became sick and died after giving pooled virus.
130	do	Control not heated	Control	2½	do	Became sick and died from virus.
140	do	100° C	15 minutes	1	do	Heated virus, no effect. Became sick and died with fresh virus.
141	do	100° C	3 hours	1	do	No effect. Died of general debility.
310	Brain and spleen emulsion	75° C	30 minutes	½	do	No effect.
310 (repeated)	Spleen emulsion	75° C	30 minutes	1	do	No effect. Became sick and died from fresh virus.
311	Brain and spleen emulsion	75° C	30 minutes	½	do	No effect.
311 (repeated)	Spleen emulsion	75° C	30 minutes	1	do	No effect. Became sick and died from fresh virus.
312	Brain and spleen	62° C	30 minutes	½	do	No effect. Died from roup.
313	Brain and spleen emulsion	62° C	30 minutes	½	do	No effect.
313	do	62° C	30 minutes	1	Intramuscular	No effect. Became sick and died from fresh virus.
314	do	55° C	30 minutes	½	Subcutaneous	Died from roup.
315	do	55° C	30 minutes	1	Intramuscular	No effect. Became sick and died from fresh virus.
316	Brain and spleen emulsion. Control.	Not heated, Control.	Control	½	Subcutaneous	Became sick and died from typical disease.
317	Nothing given	This fowl was kept side by side with experimental fowls.				Developed roup.
453	Dilute saliva	37° C	30 minutes	1	do	Became sick and died.
454	do	37° C	30 minutes	1	do	Do.
451	do	42° C	30 minutes	1	do	Do.
452	do	42° C	30 minutes	1	do	Do.
449	do	50° C	30 minutes	1	do	Do.
450	do	50° C	30 minutes	1	do	Do.

TABLE 7.—*Effect of direct sunlight on virus*

Fowl No.	Kind of virus	Time of exposure	Dose	Route	Results	Result of virulent virus
			cc.			
123	Crop contents dilute	30 minutes	2½	Subcutaneous	Became sick and died	
124	do	30 minutes	2½	do	do	
125	do	1 hour	2½	do	No effect	Became sick and died.
126	do	1 hour	2½	do	do	Died from other disease.
127	do	3 hours	2½	do	do	Became sick and died.
128	do	3 hours	2½	do	do	Do.
129	do	Control (not exposed)	2½	do	Became sick and died	

TABLE 8.—*Cross-immunity tests: Avian pest versus pseudo-fowlpest*

Immune fowl No.	Date immunized against avian pest	Date of inoculation of Java virus	Dose: emulsion of saliva and organs	Route	Results
			cc.		
106	April 18, 1928	September 29, 1928	1	Intramuscularly	Remained well.
117	April 21, 1928	do	1	Subcutaneously	Do.
196	August 12, 1928	do	1	Intravenously	Do.
212-A	August 14, 1928	do	1	Intramuscularly	Do.
217	do	do	1	Intravenously	Died a few minutes after injection.
241	August 20, 1928	do	1	Intraperitoneally	Remained well.
241-A	do	do	1	Orally	Do.
243-B	do	do	1	Subcutaneously	Do.
243-C	November 20, 1928	do	1	Intraperitoneally	Do.
244-A	September 6, 1928	do	1	Intravenously	Died a few minutes after injection.
247	Control, not immunized	do	1	Orally	Died 7 days after giving virus. [a]
248	do	do	1	Intramuscularly	Died 6 days after giving virus. [a]
249	do	do	1	Subcutaneously	Died 5 days after giving virus. [a]

[a] Symptoms and lesions of pseudo-fowlpest are similar to those of avian pest.

TABLE 9.—*Cross-immunity tests: Avian pest versus Newcastle disease*[1]

SET NO. I.—No. 1 spleen emulsion in distilled water after washing off glycerine with distilled water.

One cubic centimeter intramuscularly:

Fowl No. 344.—Injected May 15; died May 21. Typical disease. Good lesions.

Fowl No. 345.—Injected May 15; died May 25. Typical disease. Fair lesions.

Immune Fowl No. 11.—O. K. From May 15 to June 4, 1929.

Immune Fowl No. 12.—O. K. From May 15 to June 4, 1929.

Immune Fowl No. 9.—O. K. From May 15 to June 4, 1929.

Immune Fowl No. 10.—O. K. From May 15 to June 4, 1929.

SET NO. II.—No. 1 saliva in 50 per cent glycerine undiluted from tube.

One cubic centimeter intramuscularly:

Fowl No. 346.—O. K. From May 15 to May 28.

Fowl No. 347.—O. K. From May 15 to May 28.

Immune Fowl No. 13.—O. K. From May 15 to June 4, 1929.

Immune Fowl No. 14.—O. K. From May 15 to June 4, 1929.

Immune Fowl No. 15.—O. K. From May 15 to June 4, 1929.

Immune Fowl No. 16.—O. K. From May 15 to June 4, 1929.

SET NO. III.—No. 2 spleen and Nos. 2 and 3 saliva emulsion undiluted.

One cubic centimeter subcutaneously:

Fowl No. 348.—Injected May 20, 1929; died May 27, 1929. Typical disease. Good lesions.

Fowl No. 349.—Injected May 20, 1929. Sick May 28, 1929. Typical disease. Recovered.

Immune Fowl No. 9.—Injected May 20; O. K. June 4, 1929.

Immune Fowl No. 10.—Injected May 20; O. K. June 4, 1929.

Immune Fowl No. 11.—Injected May 20; O. K. June 4, 1929.

Immune Fowl No. 12.—Injected May 20; O. K. June 4, 1929.

Immune Fowl No. 13.—Injected May 20; O. K. June 4, 1929.

Immune Fowl No. 14.—Injected May 20; O. K. June 4, 1929.

Immune Fowl No. 15.—Injected May 20; O. K. June 4, 1929.

Immune Fowl No. 16.—Injected May 20; O. K. June 4, 1929.

SET NO. IV.—Emulsion of brain, kidney, liver, spleen of Fowl No. 344; died of Newcastle virus.

One cubic centimeter subcutaneously:

Fowl No. 346.—Injected May 25, 1929; died June 17 with development of paralysis.

Fowl No. 347.—Injected May 25, 1929; killed for virus May 29. Symptoms, typical; lesions, good.

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[1] English virus received: 2 tubes of spleen in 50 per cent glycerine; 3 tubes of saliva in 50 per cent glycerine in good condition. Through S. S. *Telemachus*, May 14, 1929. Cold.

SET No. V.—*Neutralization of English virus in saliva by avian pest immune serum*

Fowl	Material	Dose and route	Date	Results	Pure virus[1]	Date	Results	Remarks
Susceptible Fowl No. 359.	2 cc. avian pest immune serum; 1 cc. saliva, English virus. One day in ice-chest.	1½ cc. of mixture, intramuscularly.	6-22-29	Animal remained well.	1 cc. fresh, pooled English virus, subcutaneously.	7-5-29	Remained well.	It appears that animal had been vaccinated by the serum-virus mixture.
Susceptible Fowl No. 360.	do.	do.	do.	do.	do.	do.	do.	Do.
Susceptible Fowl No. 361, control.	2 cc., distilled water; 1 cc. saliva, English virus. One day in ice-chest.	1½ cc. of mixture, intramuscularly.	do.	Died, June 27, 1929. Symptoms, typical. Lesions, good.				Showing saliva used was virulent.
Susceptible Fowl No. 362, control.	do.	do.	do.	Animal remained well.	1 cc. fresh pooled English virus, subcutaneously.	7-5-29	Remained well.	Animal may be immune, or also vaccinated.

[1] This virus is shown to be virulent (from Fowls Nos. 354 and 355); see Set No. VI.

SET No. VI.—*Neutralization of English virus in organ emulsion and avian pest immune serum* [1]

Fowl	Material	Dose and route	Date	Results	Pure virus	Date	Results	Remarks
Susceptible Fowl No. 353.	1 cc. avian pest immune serum; 1 cc. English virus emulsion. One day in ice-chest.	1 cc. mixture intramuscularly.	6-28-29	Animal remained well.	Fresh pooled English virus	7-5-29	Became sick but recovered.	
No. 354	do	do	do	do	do	do	Became sick, paralysis developed. Died 7-13-29.	Symptoms and lesions were not different from avian pest.
No. 355	5 cc. avian pest immune serum; 1 cc. English virus emulsion. One day in ice-chest.	3 cc. of mixture intramuscularly.	do	do	do	do	Became sick: symptoms, typical; lesions, good. Died 7-12-29.	Do.
No. 356	do	do	do	do	do	do	Became sick but recovered.	Injected later with avian pest virus. No effect.
No. 357 (control to serum).	5 cc. normal fowl serum; 1 cc. English virus emulsion. One day in ice-chest.	3 cc. of mixture intramuscularly.	do	Became sick: symptoms, typical; lesions, good. Died 7-3-29.				
o. 358 (control to serum).	5 cc. normal fowl serum; 1 cc. English virus emulsion. One day in ice-chest.	3 cc. of mixture intramuscularly.	6-28-29	Became sick: symptoms, typical; lesions, good. Died 7-4-29.				
No. 370 (control to virus).	Pure English virus organ emulsion in distilled water. One day in ice-chest.	½ cc. of emulsion intramuscularly.	do	Became sick: symptoms, typical; lesions, good. Died 7-3-29.				
No. 371 (control to virus).	do	do	do	Became sick: symptoms, typical; lesions, good. Died 7-3-29.				

[1] Emulsion of spleen, brain, liver, and kidney was filtered through paper to avoid large particles. Virus was then accessible to the action of antibodies in the serum.

SET NO. VII.—*Cross-immunity test: English virus versus fowls immunized with avian pest vaccine*

Fowl	Material	Dose	Route and date	Results
Immune Fowl No. 338	Emulsion of spleen, brain, liver and kidney of fowls dead from English virus.	½ cc.	Subcutaneously July 5, 1929	Remained well up to July 18, 1929.
Immune Fowl No. 341	do.	do.	do.	Do.
Immune Fowl No. 342	do.	do.	do.	Do.
Susceptible Fowl No. 354 of Set VI, control.	do.	do.	do.	Became sick; symptoms, typical; lesions, good. Died July 13, 1929.
Susceptible Fowl No. 355 of Set VI, control.	do.	do.	do.	Became sick; symptoms, typical; lesions, good. Died July 12, 1929.

TABLE 10.—*Cross-immunity tests: Ranikhet disease versus avian pest*

Date	Fowl No.	Form of Ranikhet virus	Dose	Route	Results
March 28, 1930	439	Diluted saliva with distilled water.	1 cc.	Subcutaneously	Rise of temperature, third day. Appeared sick 4th day. Recovered in 4 days.
Do.	440	do.	do.	do.	Rise in temperature, 4th day. Died on 6th day. Typical avian pest.
Do.	Avian Pest Immune A	do.	do.	do.	Remained well.
Do.	Avian Pest Immune B	do.	do.	do.	Do.
Do.	Avian Pest Immune C	do.	do.	do.	Do.
Do.	Avian Pest Immune D	do.	do.	do.	Do.
April 3, 1930	441	Dilute aqueous emulsion of spleen from P. I. Fowl No. 440 Ranikhet Disease.	do.	do.	Rise in temperature 3rd day. Died on 5th day. Typical avian pest.
Do.	442	do.	do.	do.	Rise in temperature 3rd day. Died on 5th day. Typical avian pest.
Do.	Avian Pest Immune E	do.	do.	do.	Remained well.
Do.	Avian Pest Immune F	Dilute aqueous emulsion of spleen from P. I. Fowl No. 440 Ranikhet Disease.	do.	do	Remained well.
April 4, 1930	445	Aqueous emulsion organs in pure glycerine from India, 3-3-30 to 4-4-30.	do.	do.	Rise in temperature on 3rd day; symptoms on 5th day. Died from typical avian pest on the 7th day.
Do.	446	do.	do.	do.	Rise in temperature on 2nd day; symptoms on 5th day. Typical avian pest.
Do.	Avian Pest Immune G	do.	do.	do.	Remained well.
Do.	Avian Pest Immune H	do.	do.	do.	Remained well.
Do.	447	Organ emulsion in distilled water shipped from India 3-3-30 to 4-4-30.	do.	do.	Rise in temperature and symptoms on 4th day. Died on 5th day. Typical avian pest.
Do.	448	do.	do.	do.	Rise of temperature and symptoms on 4th day. Paralysis. Died on 6th day. Typical avian pest.

TABLE 11.—*Curative effect of immune serum*

Fowl No.	Stage of disease	Dose of immune serum	Route	Results
121	Beginning to gasp; high temperature.	Blood transfusion, 5 cc.	Intravenously.	Recovered but developed nervous symptoms, curling of neck and death from inanition.
175	Height of disease	Immune serum 3 cc.	do.	Recovered in 7 days after serum. Stood 250 M. I. D. Immunized.
213	do.	do.	do.	Recovered in 5 days after giving serum.
231	do.	do.	do.	Recovery in appetite and feces but paralysis, moon-blindness, neck inappetence. Died from emaciation or inanition.
245	do.	Sheep serum, 4 cc.	do.	Died next day after injection.
260	First day of symptoms	Immune serum, 3 cc. and 3½ cc.	do.	Recovered with double twisting of neck. Killed for serum 22 days after giving virus.
261	Control	No serum		Became sick and died on 5th day.
266	Height of disease	Organs; testes, kidney and spleen of immune fowl, 5 cc.	Intramuscularly.	No appreciable help from this kind of treatment. Fowl died.
267	do.	do.	do.	Do.
268	do.	do.	do.	Do.
269	do.	do.	do.	Do.
290	Height of disease	2 cc.	do.	Delayed death, but proved insufficient to protect animal.
291	Second day sick	3 cc.	Intravenously.	Recovered and immunized.
292	First day	4 cc. saline washing of immune red cells.	do.	Fowl died.
302	Third day of sickness	3 cc.	do.	Recovered and immunized.
305	Second day of sickness	2½ cc.	do.	Do.
352–A [1]	2 days sick; 32 days of typical illness	3 cc.	do.	Fowl died of pyrexia.
352–B	1 day sick; typical	3 cc.	do.	Fowl recovered and returned to owner.
423	2 days sick	2½ cc.	do.	Recovered.
424	1 day sick	2½ cc.	do.	Died after long illness.
426	Control			Died in six days from date of virus injection.
427	2 days sick	2½ cc.	Intravenously	Recovered.
428	Control			Died in 6 days from date of virus injection.

[1] Game rooster, field case.

TABLE 12.—*Passive immunization with immune serum*

Fowl No.	Dose of serum	Route	Virus dose 1 day later	Route	Results
183	$\frac{5}{10}$ cc.	Intravenous	125 M. I. D.	Intravenous	Became sick and died despite treatment.
184	1 cc.	do.	do.	do.	Became sick and died despite treatment.
185	$1\frac{1}{2}$ cc.	do.	do.	do.	Became sick with a delayed reaction.
186	2 cc.	do.	do.	do.	Became sick and recovered and immunized.
186–A	None (control)		do.	do.	Became sick and died.
187	$\frac{5}{10}$ cc.	Intravenous	do.	do.	Do.
188	1 cc.	do.	do.	do.	Remained well.
189	$1\frac{1}{2}$ cc.	do.	do.	do.	Became sick, reaction delayed, recovered.
190	2 cc.	do.	do.	do.	Became sick, apparently recovered but died of debility.
190–A	None.		do.	do.	Became sick and died.

ILLUSTRATIONS

PLATE I. A group of sick fowls under field conditions

PLATE II. A recovered hen with tibio-metatarsal paralysis

PLATE III. A recovered rooster with a nervous derangement manifested by twisting of the neck, aimless movements, and unsteady gait

PLATE IV. Guinea fowl two days sick. Note gasping

PLATE V. Fowls at different stages of the disease

A PRELIMINARY REPORT ON DRIED RINDERPEST VACCINE

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FIVE TEXT FIGURES

Rinderpest in the Philippine Islands has been and still is a problem, for although the disease is no longer the scourge that it was ten or fifteen years ago, still, up to the present time, it has resisted all efforts to completely eradicate it. Obviously, therefore, opportunities for research and further improvements exist as regards our present methods of control, especially so along the lines of prophylactic immunization.

The first attempt to evolve and develop a kind of tissue vaccine for immunization purposes in the Islands was made by Boynton(1), who produced one that was used extensively, beginning in 1921, to supplement the "quarantine-alone" method. In the years that followed a gradual subsidence of rinderpest was observed throughout the Islands, showing that the vaccine was partly effective in controlling the disease.

Kelser(2) in 1926, in collaboration with Youngberg and Topacio, undertook to improve the vaccine as elaborated by Boynton by introducing the use of chloroform for the preparation of the tissue, and incidentally by so doing simplified the process of manufacture.

Rodier(3) in 1927 following the possibilities indicated by Kelser's experiments, prepared a chloroform-treated vaccine from spleen, lymph glands, and tonsils. This vaccine has indeed shown its dependability for controlling field infection during the last three years, even when administered in single doses of 6 cubic centimeters for carabaos and 3 cubic centimeters for cattle.

It is to be noted, however, that the vaccines prepared by the preceding workers possessed one thing in common, i. e., inability to withstand exposure to high temperatures without showing marked loss of immunizing power. The chloroform-treated vaccine that we now use has been found to become unreliable after 48 hours of exposure to a room temperature of from

24 to 32 degrees centigrade. Experience shows that the highly perishable nature of the vaccine in the absence of ice renders the product at times difficult to handle in some sections of the Islands where transportation facilities are poor, as under present conditions, sufficient ice must be provided to keep the vaccine cold until used.

A need for a convenient vaccine adapted to withstand adverse shipping conditions without the use of ice is thus apparent. Attempts have therefore been made by the writers, with the advice and encouragement of Dr. E. A. Rodier, Pathologist and Chief of the Veterinary Research Division, to develop a type of dried rinderpest vaccine.

A review of the available literature failed to show any previous attempt to use dried rinderpest tissue for prophylactic immunization, although Boynton and Gomez had suggested its possibilities: Boynton(1) on testing the liquid and solid components of the rinderpest vaccine prepared by him found that "the liquid constituent had no immunizing power, while the solid component, made up of the parenchymatous tissue, was potent and gave excellent results." He further observed that "the vaccine held its potency somewhat longer when separated from the liquid and that the protecting dose was considerably smaller." Gomez(4) also suggested the idea of drying the rinderpest tissue in the dark.

PREPARATION OF DRIED RINDERPEST VACCINE

Susceptible animals (cattle and carabaos) previously inoculated with 10 cubic centimeters of fresh virulent blood and subsequently developing the usual rise of temperature and other clinical symptoms of rinderpest, are bled to death on the fifth or sixth day. Under aseptic precautions the spleen, lymph glands, and tonsils are removed. These organs are carefully trimmed of their fat and fascia, washed in sterile distilled warm water, immersed in 5 per cent phenol for fifteen minutes, and finally rinsed twice with sterile distilled warm water. The organs are then ground up in a meat chopper and stored in the ice chest at least overnight.

The ground up organs are then passed seven times through a Matthew's milling machine, which reduces the tissue to fine particles. The milled tissue is then strained by triturating it in a strainer fitted with 18-mesh wire gauze. The

strained pulp or tissue is collected in sterile Petri dishes that are placed in desiccators containing calcium chloride and kept in the ice chest, which is maintained at a temperature of from 0 to 8 degrees centigrade. In from three to five weeks (depending on the amount of tissue and available air space surrounding it) the tissue becomes dry and brittle. At this stage the tissue may be powdered and used.

TO PREPARE THE VACCINE FOR INOCULATION

Just prior to inoculation, the dried vaccine is triturated in a mortar until the powder thus obtained will pass through 18-mesh wire gauze. The doses required are then weighed separately. Each dose is suspended in 10 cubic centimeters of sterile water by being shaken thoroughly and immediately drawn into a syringe, which is shaken again immediately prior to injection.

Inoculation of test animals is done intramuscularly on the back about 4 to 6 inches behind the scapular cartilage.

DESCRIPTION OF THE LOTS PREPARED

Five lots were prepared as follows:

Lot D-1.—The tissue was prepared for drying on October 3, 1929. Petri dishes were half filled with the tissue and left to dry in desiccators containing calcium chloride. In about 3 weeks the tissue was dry and brittle enough to admit of pulverization. The first test on this lot was performed on December 11, 1929, or 70 days (in the ice chest) after date of preparation (Test No. 1).

Lot D-2.—The tissue was prepared for drying on January 22, 1930, and kept under the same conditions as Lot D-1. The tissue was dry in about 3 weeks. The first test was performed on February 24, 1930, or 33 days (in the ice chest) after date of preparation (Test No. 3).

Lot D-3.—The tissue was prepared on March 19, 1930, and kept as was Lot D-1. The tissue was dry in about 3 weeks. The first test was performed on April 23, 1930, or 35 days (31 days in the ice chest and 4 days at room temperature) after preparation (Test No. 23).

Lot D-4.—The tissue was prepared March 22, 1930. In this case the Petri dishes were kept in a circular museum jar containing calcium chloride. The air space surrounding the tissue

was quite limited, so drying was delayed nearly 5 weeks. The first test was performed on May 28, 1930, or 67 days (63 days in the ice chest and 4 days at room temperature) after preparation (Test No. A23).

Lot D–7.—The tissue was prepared on June 2, 1930, and kept as was Lot D–4. The tissue was dry in from 8 to 9 weeks. The first test was performed on October 1, or 120 days (in the ice chest) after date of preparation (Test No. A2). It is to be noted that the drying of this lot was quite delayed because the tissue had been prepared in thick layers.

TESTS OF VACCINE (FRAGMENTS) KEPT IN ICE CHEST

In the following and all subsequent tests performed on the dried rinderpest vaccine, highly susceptible cattle from Romblon and the Batanes Islands and carabaos from Dalupiri Island and Isabela were used. Romblon cattle have an average weight of 187 kilograms; Batanes cattle, 254 kilograms; and Dalupiri and Isabela carabaos, 362 kilograms. The test doses of 0.5–0.6 gram for cattle and 1.0–1.2 grams for carabaos were used (except in two instances) because 5 cubic centimeters and 10 cubic centimeters which are the test doses of the chloroform-treated vaccine, were found to contain approximately the preceding corresponding amounts of actual dry tissue.

The immunity of vaccinated animals was tested in all cases by inoculating them with 2 cubic centimeters of virulent blood, two weeks after the date of vaccination, one known susceptible animal being used as a control for each test. All animals that developed a typical rinderpest reaction subsequent to the virulent blood inoculation and showed no possibility of recovery, were killed for vaccine production (Fig. 5); those that developed a temperature reaction but exhibited no other clinical symptoms and finally recovered, were declared to have had a "Temperature reaction only" (Fig. 4); those that developed a mild temperature reaction for one or two days were declared to have had a "Slight temperature reaction" (Fig. 3); and those that developed no apparent reaction whatsoever were declared as such, "No reaction" (Figs. 1 and 2).

Table 1 shows the results of tests of the vaccines that were kept in the ice chest, which was maintained at a temperature of from 0 to 8 degrees centigrade.

TABLE 1.—*Showing tests of dried vaccine (fragments) kept in ice chest*

Test No.	Lot No.	Length of storage in ice chest	Dosage	Date of vaccination	Date of V. B. inoculation	Sp. and No. of animal	Results
			Grams				
1 (*a*)	D-1	70 days	1.5	December 11, 1929	December 25, 1929	Rc 9230	No reaction.
(*b*)	do	do	1.5	do	do	Rc 9226	Do.
		Control—2 cc. V. B.			do	Rc 9279	K. for vaccine.
2 (*a*)	D-1	118 days	0.6	January 29, 1930	February 12, 1930	Rc 9418	No reaction.
(*b*)	do	do	0.6	do	do	Rc 9419	Do.
(*c*)	do	do	0.6	do	do	Rc 9421	T. reaction.
		Control—2 cc. V. B.			do	Rc 9489	K. for vaccine.
A2 (*a*)	D-7	120 days	1.0	October 1, 1930	October 15, 1930	Ica 999	Do.
(*b*)	do	do	1.0	do	do	Ica 1017	Do.
		Control—2 cc. V. B.			do	Rc 255	Do.
3 (*a*)	D-2	33 days	0.6	February 24, 1930	March 12, 1930	Rc 9451	No reaction.
(*b*)	do	do	0.6	do	do	Rc 9448	Do.
		Control—2 cc. V. B.			do	Rc 9583	K. for vaccine.
4 (*a*)	D-1	153 days	0.6	March 5, 1930	March 19, 1930	Rc 9610	No reaction.
(*b*)	do	do	0.6	do	do	Rc 9634	Do.
		Control—2 cc. V. B.			do	Rc 9562	K. for vaccine.
5 (*a*)	D-2	182 days	1.2	July 23, 1930	August 6, 1930	Dca 962	No reaction.
(*b*)	do	do	1.2	do	do	Dca 963	Do.
		Control—2 cc. V. B.			do	Rc 171	K. for vaccine.

NOTE.—V.B.=virulent blood; Rc=Romblon cattle; Dca=Dalupiri carabao; Ica=Isabela carabao; K.=killed; T.=temperature.

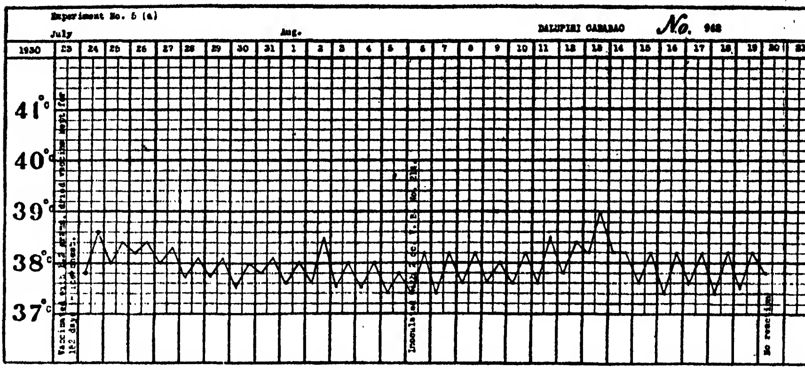

FIG. 1. Temperature chart of test animal No. 962. Vaccinated (with dried vaccine kept in the ice chest for 182 days) and showing no reaction to virulent blood inoculation.

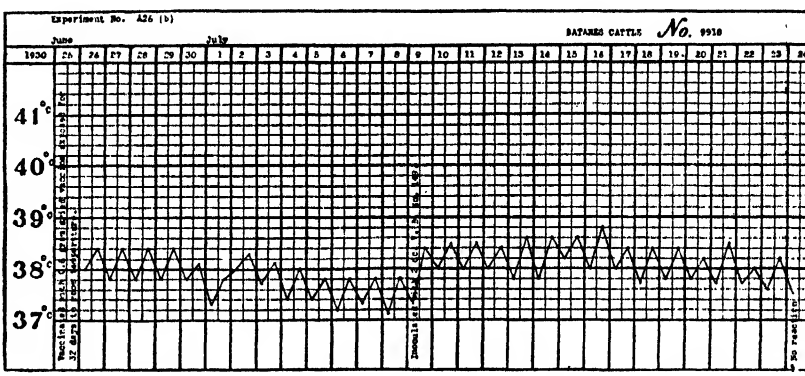

FIG. 2. Temperature chart of test animal No. 9918. Vaccinated (with dried vaccine exposed for 32 days to room temperature) and showing no reaction to virulent blood inoculation.

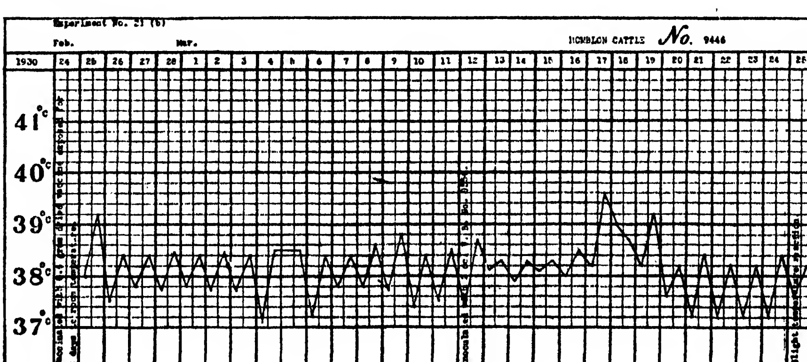

FIG. 3. Temperature chart of test animal No. 9446. Vaccinated (with dried vaccine exposed for 2 days to room temperature) and showing slight temperature reaction to virulent blood inoculation.

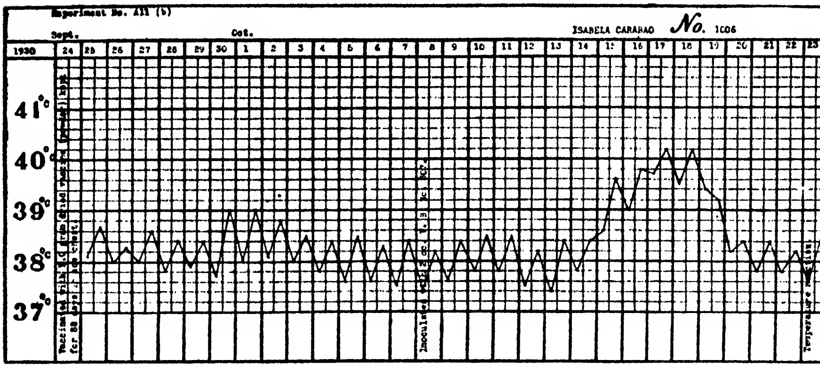

FIG. 4. Temperature chart of test animal No. 1006. Vaccinated (with dried vaccine powder kept for 88 days in ice chest) and showing temperature reaction to virulent blood inoculation.

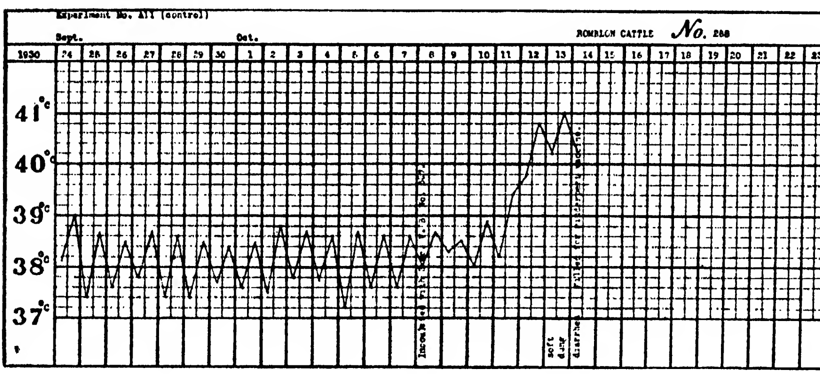

FIG. 5. Temperature chart of control animal No. 288. Unvaccinated and showing acute typical rinderpest reaction (high temperature and other clinical symptoms) to virulent blood inoculation.

According to the results shown in Table 1, vaccine kept for 182 days in the ice chest suffered no appreciable loss of immunizing power, with the exception of Lot D–7 (Test No. A2) which was found to have lost its potency at the end of 120 days. It is to be observed, however, that it took more than twice as long to dry Lot D–7 than any of the lots used in the other tests, which might have partly influenced the results obtained in this particular case. Furthermore, it is also shown in Table 1 that 33 days of drying in the ice chest apparently rendered the tissue avirulent (Test No. 3).

TESTS OF VACCINE (FRAGMENTS) KEPT AT ROOM TEMPERATURE

Three lots kept in opaque receptacles containing calcium chloride were exposed to a room temperature of from 24 to 32 degrees centigrade. Table 2 shows the results of the tests.

According to the results shown in Table 2, vaccine in fragment form exposed to room temperature for from 2 to 6 days was potent in all cases, while for 32 days it was potent in five out of six cases. It is to be noted further that 35 days (31 to 33 days in the ice chest plus from 2 to 5 days at room temperature) of drying apparently rendered the tissue avirulent (Tests 21, 22, 23, and 24).

TESTS OF VACCINE (POWDER) KEPT IN ICE CHEST

In the following tests, an attempt was made to study the behavior of the dried vaccine when kept in powder form, as it would be impractical to send vaccine in fragment form to the field, since its preparation for use would necessarily be done under adverse conditions, involving too great a danger of contamination. The vaccine, after having been powdered, was kept in amber colored bottles, sealed, and stored in the ice chest until used. The two lots used, viz., D-3 and D-4 were 98 and 95 days old, respectively, in fragment form and of proved potency. Table 3 shows the results.

According to the results shown in Table 3, powdered vaccine kept for 84 to 91 days in the ice chest conferred an apparently low degree of immunity, as shown by the temperature reaction subsequent to virulent blood inoculation, in three out of the four test animals used.

TEST OF VACCINE (POWDER) EXPOSED TO SHIPPING CONDITIONS

A sample of dried rinderpest vaccine (Lot D-3) over three months old in fragment form and of proved potency was powdered and sent by mail to Dr. T. F. Rivadelo, who was at Bontoc, Mountain Province, on July 27. The vaccine reached its destination on July 1, where it was kept at room temperature until July 9 when it was returned by mail to the laboratory. It arrived in the lâboratory on July 17 and was tested on July 25. The vaccine was, therefore, actually exposed to 12 days in the mail and 17 days at room temperature. Table 4 shows the results of the test.

TABLE 2.—*Showing tests of dried vaccine (fragments) exposed to room temperature*

Test No.	Lot No.	Length of exposure to room temperature	Dosage	Date of vaccination	Date of V.B. inoculation	Sp. and No. of animal	Results
			Gram				
21 (*a*)	D-2	2 days	0.6	February 24, 1930	March 12, 1930	Rc 9440	T. reaction.
		(Previously kept 33 days in ice chest).					
(*b*)	do.	do.	0.6	do.	do.	Rc 9446	S. T. reaction.
		Control—2 cc. V. B.				Rc 9583	K. for vaccine.
22 (*a*)	D-2	3 days	0.6	February 25, 1930	March 12, 1930	Rc 9432	No reaction.
		(Previously kept 33 days in ice chest).					
(*b*)	do.	do.	0.6	do.	do.	Rc 9456	Do.
		Control—2 cc. V. B.			do.	Rc 9583	K. for vaccine.
23 (*a*)	D-3	4 days	0.6	April 23, 1930	May 7, 1930	Bc 9902	S. T. reaction.
		(Previously kept 31 days in ice chest).					
(*b*)	do.	do.	0.6	do.	do.	Bc 9903	T. reaction.
		Control—2 cc. V. B.			do.	Rc 9946	K. for vaccine.
A23 (*a*)	D-4	4 days	0.6	May 28, 1930	June 11, 1930	Bc 9830	No reaction.
		(Previously kept 63 days in ice chest).					
(*b*)	do.	do.	0.6	do.	do.	Bc 9895	Do.
		Control—2 cc. V. B.			do.	Rc 9925	K. for vaccine.
24 (*a*)	D-3	5 days	0.6	April 24, 1930	May 9, 1930	Bc 9910	T. reaction.
		(Previously kept 31 days in ice chest).					
(*b*)	do.	do.	0.6	do.	do.	Bc 9917	T. reaction.
		Control—2 cc. V. B.			do.	Rc 9909	K. for vaccine.
A24 (*a*)	D-4	5 days	0.6	May 29, 1930	June 13, 1930	Bc 1	No reaction.
		(Previously kept 63 days in ice chest).					
(*b*)	do.	do.	0.6	do.	do.	Bc 9	Do.
		Control—2 cc. V. B.			do.	Rc 772	K. for vaccine.
25 (*a*)	D-4	6 days	0.6	May 30, 1930	June 13, 1930	Bc 9919	No reaction.
		(Previously kept 63 days in ice chest).					
(*b*)	do.	do.	0.6	do.	do.	Bc 9877	Do.
		Control—2 cc. V. B.			do.	Rc 722	K. for vaccine.
26 (*a*)	D-3	32 days	0.6	May 21, 1930	June 4, 1930	Bc 9920	No reaction.
		(Previously kept 31 days in ice chest).					
(*b*)	do.	do.	0.6	do.	do.	Bc 9921	Do.
		Control—2 cc. V. B.			do.	Bc 9909	K. for vaccine.
A26 (*a*)	D-4	32 days	0.5	June 25, 1930	July 9, 1930	Bc 11	No reaction.
		(Previously kept 63 days in ice chest).					
(*b*)	do.	do.	0.6	do.	do.	Bc 9918	Do.
(*c*)	do.	do.	1.0	do.	do.	Dca 957	Do.
(*d*)	do.	do.	1.0	do.	do.	Dca 978	K. for vaccine.
		Control—2 cc. V. B.			do.	Rc 232	Do.

NOTE.—V.B.=virulent blood; Bc=Batanes cattle; K.=killed; Rc=Romblon cattle; Dca=Dalupiri carabao; T.=temperature; S.T.=slight temperature.

TABLE 3.—*Showing tests of dried vaccine (powder) stored in ice chest*

Test No.	Lot No.	Length of storage in ice chest	Dosage	Date of vaccination	Date of V. B. inoculation	Sp. and No. of animal	Results
			Gram				
41 (*a*)	D-3	84 days	1.0	September 17, 1930	October 1, 1930	Ica 1008	T. reaction.
(*b*)	do.	do.	1.0	do.	do.	Ica 1022	No reaction.
		Control—2 cc. V. B.			do.	Rc 247	K. for vaccine.
A41 (*a*)	D-4	91 days	1.0	September 24, 1930	October 8, 1930	Ica 995	T. reaction.
(*b*)	do.	do.	1.0	do.	do.	Ica 1006	Do.
		Control—2 cc. V. B.			do.	Rc 248	K. for vaccine.

NOTE.—V.B.=virulent blood; Rc=Romblon cattle; Ica=Isabela carabao; K.=killed; T.=temperature.

TABLE 4.—*Showing test of dried vaccine (powder) exposed to shipping condition*

Test No.	Lot No.	Length of exposure to shipping	Dosage	Date of vaccination	Date of V.B. inoculation	Sp. and No. of animal	Results
			Gram				
81 (*a*)	D-3	29 days	0.6	July 25, 1930	August 8, 1930	Bc 3	No reaction.
(*b*)	do.	do.	1.2	do.	do.	Dca 982	K. for vaccine.
(*c*)	do.	do.	1.2	do.	do.	Dca 974	Do.
		Control—2 cc. V. B.			do.	Rc 40	Do.

NOTE.—V.B.=virulent blood; Rc=Romblon cattle; Bc=Batanes cattle; Dca=Dalupiri carabao; K.=killed.

Although nothing was definitely proved by this test (shown in Table 4), yet it indicated that the vaccine deteriorated when subjected to unfavorable conditions for a considerable length of time.

SUMMARY AND CONCLUSIONS

The preceding experiments showed that drying of tissue rich in rinderpest virus in a desiccator under constant refrigeration rendered the tissue avirulent without destroying its immunizing power. In five separate tests where two different lots (33 to 36 days old) were used, none of them produced rinderpest in susceptible animals.

At the same time it was shown that vaccine kept in the ice chest for 182 days in fragment form remained potent. Likewise, vaccine exposed to room temperature for from 2 to 6 days showed no loss of immunizing power, while for 32 days it gave absolute protection in five out of six cases.

In powder form, the vaccine was observed to retain its potency, though of a low degree, as long as 91 days when kept in the ice chest. Under adverse shipping conditions and in the absence of ice, however, the vaccine was found to show a marked loss of immunizing power.

Thus the possibility of using dried rinderpest vaccine for purposes of immunization has been definitely shown. As such its relative future value will depend upon whether or not this vaccine can be so improved as to meet our field requirements as follows: (1) ability to withstand high temperature exposure in powder form, maintaining its potency for a minimum of at least 10 days to provide for sufficient time for shipment and injection in the most isolated places; (2) the finding of a suitable vehicle that will keep the powdered vaccine in a uniform suspension suitable for field use; and (3) feasibility of quick drying in large quantities under constant refrigeration.

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ILLUSTRATIONS

TEXT FIGURES

ŒSOPHAGOSTOMIASIS OF CATTLE IN THE PHILIPPINES

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TWO PLATES AND FOUR TEXT FIGURES

The object of the present paper is to give a brief report on the incidence of œsophagostomiasis of cattle in the Philippines and to record some notes with regard to diagnosis and control.

While the disease is apparently common in this country, former investigators seem to have missed observing this malady here. A review of the literature on the subject, particularly that of Schwartz(1) in 1925 on the internal metazoan parasites of ruminants, which summarizes the species of parasites of ruminants in the Philippine Islands, fails to disclose the occurrence of this disease. Boynton and Wharton, cited by Schwartz(1) referred to a species of *Œsophagostomum* in a cow in Minalabac, Camarines Sur. This parasite differed in many respects from *Œsophagostomum radiatum*, which is the one reported in this paper as found to be responsible for the causation of nodular disease of cattle examined here.

Œsophagostomiasis, otherwise known as nodular strongylosis or nodular disease, is essentially an intestinal affection characterized by the presence of nodules in the small and large intestines, and rarely in the liver and other abdominal organs. These nodules vary in size from that of pinhead to even larger than a corn grain. In color these nodules are grayish white, or yellowish or blackish. The contents may be of purulent, cheesy, or calcareous material, depending upon the size and age of the nodules. Younger nodules contain the encysted larvae of the genus *Œsophagostomum.* The disease results in emaciation of the host. Serious cases may terminate in slow death.

INCIDENCE

No extensive investigation was conducted to ascertain the distribution of this species throughout the Archipelago. However, there is enough evidence that this infestation is not rare.

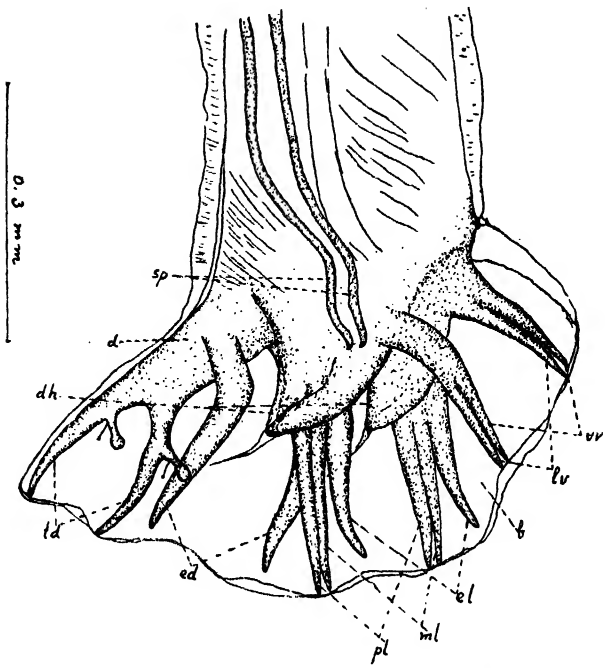

FIG. 1. *OESOPHAGOSTOMUM RADIATUM.*—Posterior extremity: *d*—dorsal ray; *td*—terminal branches of dorsal ray; *ed*—externo-dorsal rays; *pt*—postero-lateral rays; *md*—medio-lateral *rays; el*—externo-lateral rays; *lv*—ventro-lateral rays; *vv*—ventro-ventral rays; *dh*—dorsal projection of trunk of lateral rays; *sp*—spicules.

The writer had the privilege of undertaking a study as to the probable cause of the emaciated condition of some cattle in a stock farm of this Bureau's in Nueva Ecija. About thirty head were culled out from the Bureau herd. Of these twelve were available for ante-mortem inspection and five were slaughtered under the supervision of the writer. All of these slaughtered animals were carefully autopsied and each one was found to be affected with nodular disease in a more or less severe form. Adult worms were collected from two of these animals. Nodules were numerous in the small intestines and in the cæcum. Adult forms were found in the ileum and cæcum.

All of these animals were born on the farm.

Two other cattle from the same Government stock farm slaughtered in the abattoir at Pandacan, Manila, were found to be badly infested with these parasites.

Autopsies performed in the laboratory on cattle that came from the Batanes Islands and cattle from Romblon showed that this parasite (*Œsophagostomum radiatum*) was often met

with. These animals were transported from boats to the premises of the laboratory by means of trucks. They were never pastured in Manila before they were autopsied.

This experience tended to reveal the fact that nodular disease of cattle is of common occurrence in these Islands.

SPECIFIC DIAGNOSIS

In the identification of certain species of worms it is often necessary to consult a number of works. This treatise for obvious reasons gives a comprehensive data on classification as well as nomenclature.

Classification:

Phylum Coelhelminthes
Class Nemathelminthes
Family Strongylidae Baird, 1853
Subfamily Œsophagostominae Raillet, 1915
Genus Œsophagostomum Molin, 1861
Species Œsophagostomum radiatum (Rud. 1803) Raillet, 1898

Different names:

Strongylus radiatus Rudolphi, 1803
Strongylus inflatus Schneider, 1866
Strongylus dilatatus Raillet, 1884
Œsophagostomum inflatum Raillet, 1885
Œsophagostomum dilatatum Raillet, 1896
Œsophagostomum radiatum Raillet, 1898
Œsophagostomum bovis Schnyder, 1906
Œsophagostomum radiatum Ransom, 1911
Proteracum radiatum Raillet and Henry, 1913
Œsophagostomum radiatum Goodey, 1924

The name, *Œsophagostomum radiatum,* is renewed by Goodey(2) despite the new name, *Proteracum radiatum,* advanced by Raillet and Henry in 1913. Goodey(2) gives good reasons for disapproving the subgenera, (*a*) *Hysteracum* and (*b*) *Proteracum,* created by Raillet and Henry, and in view of this the generic name *Œsophagostomum* is used in this paper.

Host: Cattle (*Bos taurus*).
Location of adult worms: Ileum, large intestines (cæcum).
Localities of hosts: Batanes Islands, Nueva Ecija, Romblon.

Gross morphology.—Adult worms are whitish in color; have almost uniform thickness over their entire length; taper gradually anteriorly; posteriorly, the female ends in a pointed tail; male tapers to a certain extent then expands with a bursa at the tip. Female usually carries a dark brown mass at vulva (near base of tail) when fertilization has taken place.

Live worms curl on themselves when collected; move about in S-shaped fashion in watery feces. When fixed in hot 70 per cent alcohol, they straighten out except at the anterior portion which usually remains curved like a hook. As a whole, the worms look like minute canes (see Plates I and II). The tail of the female is slightly flexed ventralward.

Males average 14.5 millimeters in length, and 0.32 millimeter in thickness; females 18.2 millimeters in length and 0.36 millimeter in thickness.

Microscopic characters.—Mouth collar disc-like with rounded edges, more than three times as broad as deep; circum-oval papillae, six in number; tips of sub-ventral and sub-dorsal papillae sunk in pits and do not protrude out of anterior face of mouth collar. Cephalic vesicles are inflated and constructed to form a shallow annular groove at two-thirds distance from cephalic groove to cervical groove. Lateral alae or membranes well developed in both sexes; begin at some level behind annual groove and extend to posterior third; gradually thin out at posterior extremity and enlarge at the region of the vulva in the female. Cervical papillae well developed; located posterior to the cervical groove a little before middle of œsophagus; points protrude through lateral alae. Mouth opening circular; lumen of œsophagus enlarged at anterior extremity to form œsophageal funnel.

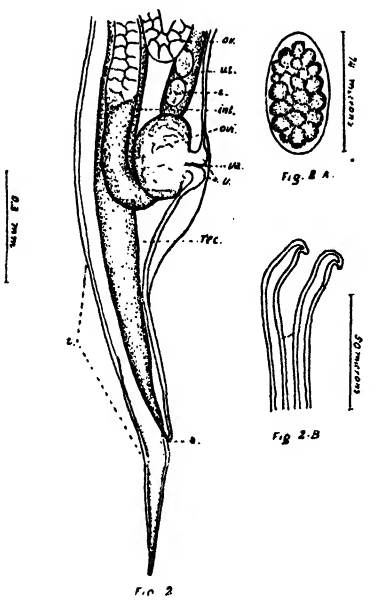

FIG. 2. *OESOPHAGOSTOMUM RADIATUM.*—Posterior extremity of female: *v*—vulva; *va*—vagina; *ut*—uterus; *ov*—ovary; *e*—egg; *ovi*—ovijector; *a*—anus; *int*—intestine; *rec*—rectum; *t*—tail. FIG. 2-A—enlarged egg; Fig. 2-B—enlarged extremities of spicules.

Male.—Bursa large and campanulate; has one dorsal and two lateral lobes. Dorsal ray stout; gives off externo-dorsal ray at level less than one-half from root of bifurcation. Externo-dorsal rays branch off at almost right angles to dorsal ray. Main dorsal ray bifurcates at some distance from edge of the bursa, giving two minor outer knobbed branches directed laterally and two directed posteriorly, the terminal branches of

which taper and reach the edge of the bursa. Length of knobbed branches, less than one-half terminal branches of dorsal ray. A small fine stalk projects from the posterior border of outer branch of bifurcated ray. Tips of ventral, ventro-lateral, medio-lateral and postero-lateral rays and the terminal branches of the dorsal ray reach edge of bursa. Tips of the externo-dorsal and the externo-lateral rays at about equal distances from border of bursa. Spicules, short, average 0.75 millimeter long.

Female.—Tail bent ventrally; lateral alae well developed behind vulva; tail gradually diminishes in thickness and ends in a slender pointed tip. Anus about 4 millimeters from tip of tail. Vulva less than 1 millimeter from anus; vulva transversely elongated and raised on a blunt muscular protuberance. Average measurement of egg, 0.042 millimeter by 0.076 millimeter (Fig. 2–A).

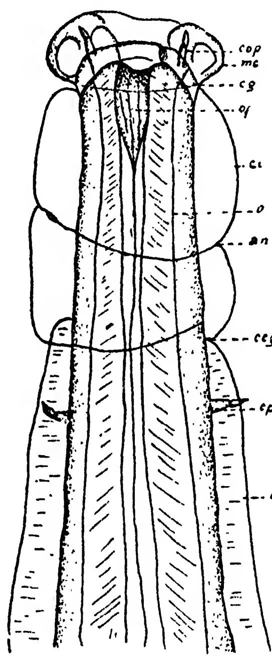

FIG. 3. *OESOPHAGOSTOMUM RADIATUM.*—Anterior extremity: *cop*—circum-oral papilla; *mc*—mouth collar; *of*—oesophageal funnel; *o*—oesophagus; *cg*—cephalic groove; *ci*—cervical inflation or cephalic vesicle; *an*—annular groove; *ceg*—cervical groove; *cp*—cervical papilla; *la*—lateral alae.

CLINICAL LABORATORY DIAGNOSIS

Animals affected with nodular disease show no particular external symptoms except anemia, loss of flesh, and rough coat in those where the infestation is heavy, habitual, or of long standing. In many instances even diarrhea is not present. Young animals as a rule are more susceptible to the attacks of this parasite than older ones. The injury is due to encystment of the larvae. When newly attacked, the mucous membrane of the small and large intestines becomes severely inflamed. The resulting enteritis, together with impaired digestion and absorption of food due to the injured mucosa and lessened area of absorption by nodular formation, causes a chronic unthriftiness. A cross-section of the diseased organ (see Fig. 4) shows that the wall of the intestines is rendered almost useless by the presence of numerous necrotic foci.

Examination of the feces affords an easy way to diagnose nodular disease only where adult worms are present in the intestines. In that event, an ordinary method—passing an emulsion of feces through a copper wire sieve or even gauze, centrifuging the finer particles and examining a cover glass preparation of the residue, diluted with a little water—is sufficient to demonstrate the eggs. Other more elaborate methods, such as those in which sugar or salt solution is used may be employed if so desired. When an animal is newly infested, an ante-mortem diagnosis would be difficult if not impossible.

An attempt to diagnose this disease by means of the Wassermann reaction was not successful. An antigen was prepared as follows: Nodules were carefully cut out from the intestines and the fat carefully removed. Then the material was placed in the Frigidaire to dry. After three days, the dried particles were soaked in ether for one day with frequent shaking, the ether being frequently renewed. Then the fat-free particles were dried for three days in the Frigidaire and then pulverized. The powder was soaked in absolute ethyl alcohol, in the proportion 10 parts of powder to 90 parts alcohol and placed for 3 days in the incubator at 37.6° centigrade with frequent shaking. The supernatant fluid was removed by decantation. This material constituted the antigen. Positive serum was obtained from one of the positive Nueva Ecija cattle slaughtered at the Pandacan abattoir.

A set-up of the complement fixation test is shown in Table 1.

TABLE 1.—*Complement fixation test of ethylic nodular disease extract vs. positive nodular disease serum*

Tubes	Antigen dilutions $\frac{5}{10}$ cc.	Whole positive serum	Complement 2 units		Red corpuscles 2 per cent	Hemolysin 2 units		Results	Remarks
		Cc.	*Cc.*		*Cc.*	*Cc.*			
1	1:25	5/10.......	1	(a)	5/10	6/10	(b)	C. H.	
2	1:50	5/10.......	1	(a)	5/10	6/10	(b)	C. H.	
3	1:100	5/10.......	1	(a)	5/10	6/10	(b)	C. H.	
4	1:200	5/10.......	1	(a)	5/10	6/10	(b)	C. H.	
5	1:400	5/10.......	1	(a)	5/10	6/10	(b)	C. H.	
6	1:800	5/10.......	1	(a)	5/10	6/10	(b)	C. H.	
7	1:1600	5/10.......	1	(a)	5/10	6/10	(b)	C. H.	
8	....	5/10.......	1	(a)	5/10	6/10	(b)	C. H.	Positive serum control.
9	....	....	1	(a)	5/10	6/10	(b)	C. H.	Hemolytic control.
10	1:25	5/10.......	......	(a)	5/10	6/10	(b)	C. I. H.	Antigen control.
11	1:25	N. S. 5/10..	1	(a)	5/10	6/10	(b)	C. H.	Negative serum control.

NOTE.—N.S.=Negative serum; C.H.=complete hemolysis; C.I.H.=complete inhibition of hemolysis.

[a] Eighteen hours in ice chest at 6° C.

[b] One-half hour at 37° C. and one hour at room temperature.

The foregoing table shows that even at a dilution of 1:25 of the antigen used, no fixation of complement was noticed. The controls in tubes Nos. 8, 9, 10, and 11 shows that the entire system was in a perfect working condition.

An antigen prepared by the extraction or suspension of powdered larvae in individual or combined salt solutions was contemplated but not carried out. The success of some workers in diagnosing helminthiasis by the Wassermann reaction indicates that this disease may be diagnosed by means of serological reactions.

METHODS OF CONTROL

The eggs undergo a certain amount of segmentation in the intestines of the host. When voided under favorable conditions these eggs continue development until they hatch into rhabditiform larvae. These larvae, after molting, soon become ensheathed when emerging into the infective stage. These larvae are geotropic, quite resistant to desiccation, and cannot penetrate the intact skin. Infestation takes place by means of ingestion by the host.

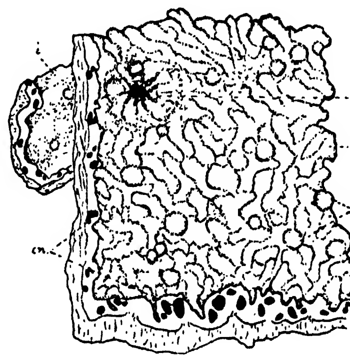

FIG. 4. Diagrammatic drawing of nodules caused by larvae of *OESOPHAGOSTOMUM RADIATUM*.—Part of ileo-caecum: *i*—ileum; *icv*—ileo-caecal valve; *c*—caecum; *in*—intact nodules; *cn*—cut nodules.

The ensheathed larvae break from their sheath in the intestines and penetrate the wall wherein they become encysted, or else they pass through the intestinal wall and invade the mesenteric lymph glands, liver or other internal organs. After undergoing a period of their growth in the nodules, they escape and enter the intestinal lumen, where they act as parasites on digested food. The adults do not seem to be very dangerous.

In view of these stages of development, control measures lie principally in the prevention of larval infestation. We, therefore, have to consider (1) the infected animal and the disposal of its feces; (2) an infected herd and the infected pasture; (3) curative measures; and (4) ranch management.

(1) The fundamental principle that "an ounce of prevention is worth a pound of cure" is as applicable to infestation with intestinal parasites as with infectious diseases. It behooves the prospective stockman, therefore, to have his animals

carefully examined for evidence of œsophagostomiasis, as well as other diseases, particularly tuberculosis, the intestinal form of which may easily be mistaken for the disease in question. The stock being proved clean, the introduction of new animals should be done only with much caution. However, the casual arrival of an infested animal may not be preventable. If an animal is found to be affected, however, immediate disposal by slaughter is recommended. In case the animal is very valuable, it should be kept in an isolated place on bare ground, but fed from raised troughs. All feces should be burned or so treated to destroy all eggs and larvae.

(2) Where a herd is infested, the most reliable control measure should be used, although necessarily, it is drastic. No sure method can be used to pick out the infested animals. If it were possible to find out the carriers of these parasites, they should be promptly killed and the non-infested ones transferred to a new pasture. But since we cannot by any means at our command always tell the infested from the non-infested, a complete change of stock and pasture oftentimes is necessary. The new animals should, of course, come from places where these worms are known not to exist.

(3) No medicine has as yet been discovered to free an infested animal from larvæ in the nodules. Medication of animals to be introduced to a herd is never reliable.

(4) A careful periodical survey to ascertain the presence of intestinal parasites in ranch animals is imperative. This should begin from the start, as the discovery of infestation after almost the whole ranch is infested would be useless as an aid in building up a livestock business. At that stage nothing can be done to improve the condition. Disposal of all animals and a new and right start is in order.

Rotation of pasture, burning and cultivating old ones help, but do not eliminate parasitic infestation, because an animal cannot be purged completely of its nodular worms.

An empirical treatment of sheep in Queensland is claimed to enable the sheep to escape the infestation of œsophagostomes. Professor Dr. T. Brailsford Robertson, Chief of the Division of Animal Nutrition, Council for Scientific and Industrial Research, Austrialia (3) reports that the benefit accruing from licks made of salt and rock phosphate is undoubted. Robertson (3) states that Mr. A. J. N. Gillespie of "Orion Downs" ob-

served that on stations employing phosphate lick œsophagostomiasis is absent; neighboring stations not administering this lick to their sheep are heavily infested.

Phosphate licks may be tried for cattle to prevent cattle œsophagostomiasis.

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(4) GOODEY, T. The anatomy of *Œsophagostomum dentatum* (Rud.), a nematode parasite of the pig, with observations on the structure and biology of free-living larvæ. Journal of Helminthology, 1924, ii, No. 1, 1–14.

ILLUSTRATIONS

TEXT FIGURES

FIG. 1. *Œsophagostomum radiatum.*—Posterior extremity: *d*—dorsal ray; *td*—terminal branches of dorsal ray; *ed*—externo-dorsal rays; *pt*—postero-lateral rays; *md*—medio-lateral rays; *el*—externo-lateral rays; *lv*—ventro-lateral rays; *vv*—ventro-ventral rays; *dh*—dorsal projection of trunk of lateral rays; *sp*—spicules.

2. *Œsophagostomum radiatum.*—Posterior extremity of female: *v*—vulva; *va*—vagina; *ut*—uterus; *ov*—ovary; *e*—egg; *ovi*—ovijector; *a*—anus; *int*—intestine; *rec*—rectum; *t*—tail. Fig. 2-A—enlarged egg; Fig. 2-B—enlarged extremities of spicules.

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4. Diagrammatic drawing of nodules caused by larvæ of *Œsophagostomum radiatum.*—Part of ileo-cæcum: *i*—ileum; *icv*—ileocaecal valve; *c*—cæcum; *in*—intact nodules; *cn*—cut nodules.

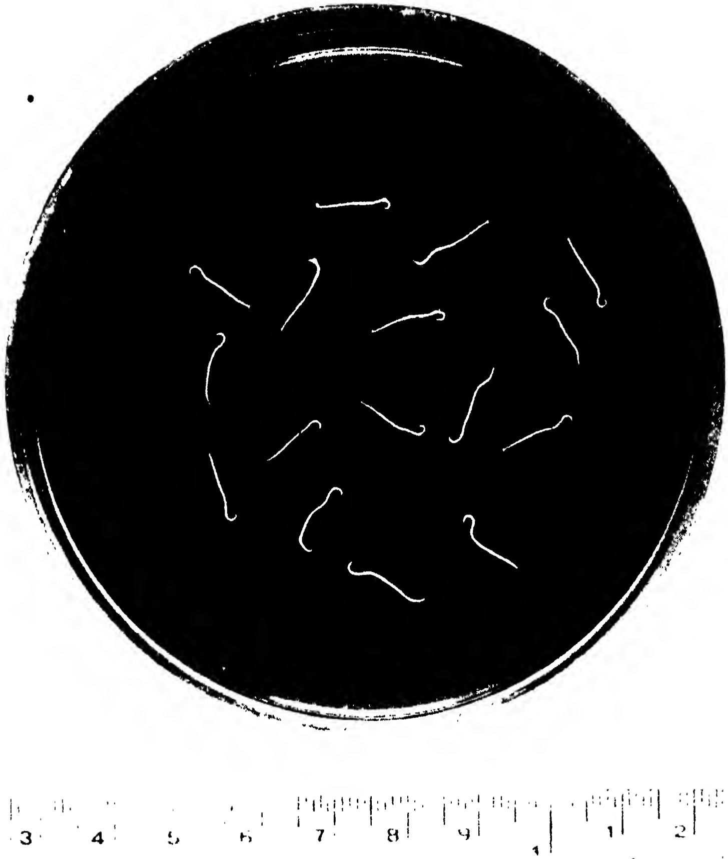

PLATE I. Male worms, natural size

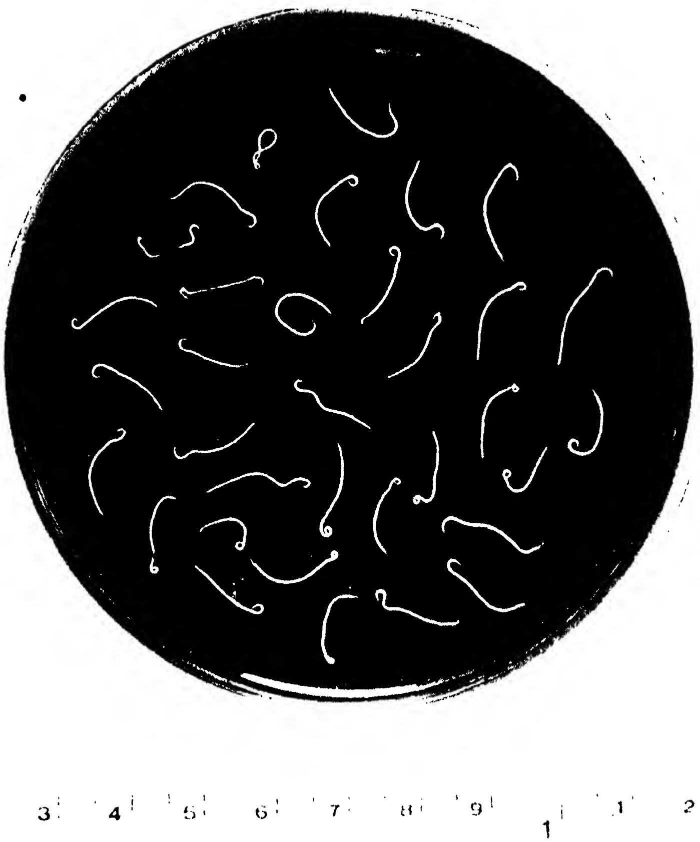

PLATE II. Female worms, natural size

A BRIEF RÉSUMÉ OF RINDERPEST CONTROL WORK IN THE PHILIPPINES

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With the coming of the Philippine Commission in 1900, the need for the control of rinderpest made itself felt most acutely because of the disastrous effect it was having on agriculture. The change of government and the general unsettled condition of the country had given this disease a chance to invade many provinces of Luzon and the southern islands before any adequate measures could be established.

The fact that it caused the loss of about 80 per cent of cattle and carabaos at this time leaves no room for argument that the disease was of relatively new introduction. The first introduction, it is generally believed, was in 1886 when some work animals imported from China brought it in.

That this is the approximate date is further deduced from two official records. One is "Una Epizootia en Filipinas," by D. Gines Geis Gotzens, an army veterinarian. This was published in Manila in 1888 and states that in December of 1887 the disease had spread to central Luzon, along the Ilocos coast, Nueva Vizcaya, Cagayan Valley, Batangas, and Tayabas Provinces. In the south, Iloilo and Capiz Provinces in Panay Island were also reported infected. The other document is a report of the United States consul in Manila who reported on February 23, 1891, that three years before the beef cattle were attacked by a disease with symptoms resembling those of "epizootia." From this it is clear that he was referring to the outbreak mentioned by Gotzens.

From our present knowledge of the course of unchecked rinderpest epidemics in an unfenced country, where wild hogs, deer, and semi-wild herds of cattle abound in the mountainous regions, and wide grassy plains, the disease must have run a sporadic and mild course after the first severe onset.

Gotzens, who made his studies early in 1888, complained that he could not find many cases to work on, so that it can be in-

ferred that the epidemic was dying out about the year 1888. Therefore, the outbreak which occurred about the time of American occupation in 1898 was but ten years after the previous outbreak. During this lapse of time a new crop of susceptible animals were born and they constituted the material for the new outbreaks. This recurrence of epizoötics in cycles of every ten years has been observed in countries where rinderpest is endemic. The same phenomenon has been observed in this country. The conditions were favorable for the spread of the disease because of the movements of both American and Filipino troops.

The unsettled conditions and poor transportation facilities in the provinces helped to increase the importation into Manila of Chinese and Australian cattle. Shipments of the former often arrived infected with rinderpest. This trade proved to the importers to be profitable and it grew steadily until the cattle slaughtered were almost exclusively imported animals. And this trade flourished, but unfortunately it kept on bringing in new virus of the disease. It took a long and hard fight to restrict and put under control the importation from China, which was begun about 1907, and was only brought fully under control in 1922 when cattle and carabaos imported from Hongkong, French Indo-China, and British India were required to be previously immunized to rinderpest by the simultaneous method.

The government branches first given the task of fighting the disease were the Board of Health and the Bureau of Government Laboratories and later on the Bureau of Agriculture, from after the establishment of Civil Government in July, 1901, to November 1, 1905, when the Veterinary Division of the Board of Health was transferred to the Bureau of Agriculture, being incorporated with the Division of Animal Industry of the latter Bureau, by Act No. 1407, enacted on October 26, 1905. During those early days the personnel of these bureaus was limited in the extreme. The serum laboratory manufactured the anti-rinderpest serum and virus. The technical instructions were given out from this office. The field force consisted of the veterinarians and inoculators of the Veterinary Department of the Board of Health. In the field operations the Bureau of Agriculture personnel assisted. On one occasion the assistant director of this Bureau went to Tablas Island to inoculate animals.

The veterinary department of the Board of Health had been

in existence since April 22, 1899, having been organized by an order of the provost-marshal-general. Its duties were the inspection of all animals arriving in Manila; the inspection of animals slaughtered in the Matadero for food purposes; the care and treatment of the government animals, and the inspection of government and private stables with reference to their sanitary condition and the health of the animals.

By resolution of the Philippine Commission, dated July 27, 1903, a Veterinary Division under the control of the Board of Health was authorized for the purposes of investigating and suppressing diseases of the carabaos, cattle, horses, and other animals in the Archipelago, such as rinderpest, surra, glanders, and other contagious diseases.

The Veterinary Division was, however, actually established by another resolution of the same Commission, that of February 27, 1904, to take effect April 1, 1904, and was to consist of a chief veterinarian, 4 veterinarians, 4 emergency veterinarians, 15 American inoculators, and 5 Filipino inoculators. By the latter part of 1905 the inoculator force consisted of 30 first class and 15 second class inoculators. It was not at full strength always, however. The places were filled only as it became necessary. At this time the force was sent out into the field in units of one veterinarian, two inoculators of the first class and one inoculator of the second class. Each unit covered several provinces, which constituted a district.

This authorized strength of the force remained unchanged until 1908. Difficulties were experienced in securing veterinarians from the United States. The Director of Agriculture states in his report for the fiscal year ended June 30, 1907, that this scarcity of veterinarians willing to accept appointments in spite of the adequate salaries offered was due to that meat inspection law that went into effect in the United States in 1906, which provided for entrance salaries of veterinarians at from $1,200 to $1,400; and also to business conditions in the States, which contributed to make private practice very profitable.

Five agricultural inspectors were given instructions to help in the suppression of contagious diseases in the provinces on June 30, 1909. At the beginning of the year there were 14 veterinarians. The number was increased to 22 before the close of the year. However, only 14 of these were available for duty in the provinces, as one was in charge of Trinidad Stock Farm,

one in charge of the serum laboratory, four stationed in the ports of entry (Manila, Iloilo, and Cebu), and one loaned to the Bureau of Prisons.

Because of the difficulty of securing veterinarians from the States, the Secretary of the Interior of 1907 made the following statement: "In view of the difficulty of securing competent veterinarians it is believed that early consideration should be given the question of the advisability of establishing here a veterinary school." The opening of the veterinary school did not take place until 1911, on which date began the Filipinization of the personnel of the division. In 1929 there were only three American veterinarians on the force.

At the beginning of the fiscal year ending 1910, there were 31 veterinarians on duty throughout the year, 8 agricultural inspectors, 6 American inoculators, and 56 Filipino inoculators being employed in veterinary work.

In 1911 there were on duty 47 veterinarians, one veterinary pathologist, one veterinary entomologist, 56 American livestock inspectors and about 300 Filipino livestock inspectors. From 1914 to 1920, the number of veterinarians varied from 16 to 29. The number of veterinarians from 1921 never was under 30 until the close of 1929. The American livestock inspectors were gradually let out from 1914 until but two remained in the service in 1929. The force of Filipino inspectors has varied from about 300 to 140 since then. Most of these are temporary employees and their number is increased or reduced according to the exigencies of the service. In the Appropriation Act for 1920, forty-two positions were created for permanent livestock inspectors. This number was later reduced to nineteen because the greater number of these positions (25) provided for salaries of ₱480 per annum each, and this salary was not big enough to allow incumbents to be transferred very frequently from one point to another. It was originally expected to use this force as a moveable body of inspectors that could be sent at short notice where badly needed, but as stated the men could not be moved as frequently as necessary without causing undue hardships to the majority of them on account of the meager pay. The efforts exerted to secure higher wages for this class of employees have failed on account of the Government retrenchment policy.

Ever since 1906 the aim has been to have at least one veterinarian for each province, but the economic condition of the country has not made its realization possible and the veterinary force has existed to the present as an emergency force.

METHODS EMPLOYED IN THE CONTROL OF THE DISEASE

To write of the history of the Veterinary Division and its accomplishments is to write of the fight against rinderpest and the gains made against it. Although other contagious diseases of animals such as anthrax, hemorrhagic septicemia, surra, and glanders have been encountered from the early years of the service, after suppressing their occasional outbreaks all available resources have been concentrated on the control of rinderpest. This disease did the greatest damage to agriculture and commerce as the decimation of the herds of carabaos, which is the principal work animal for agricultural and draft purposes, the sole recourse before the advent of good roads and motor transportation, practically paralyzed agriculture and commerce. Consequently the control of rinderpest was the first thing attempted and not until this was fairly under control did the other diseases receive more attention in accordance with their relative importance. Moreover, the meat supply had to be insured.

The Veterinary Division did not exist or function as a corps until after the transfer of the veterinarians from the Board of Health to the Bureau of Agriculture in the latter part of 1905.

During the time that the rinderpest control work was under the Board of Health the first method tried out to immunize carabaos and cattle was the glycerinated bile method. This was reported as giving satisfactory results at first, but when used more extensively did not do so. This failure was due to the fact that native animals were more susceptible than those on which this method was first tried out and reported as satisfactory. Those who were in charge of the work soon found that the immunity obtained by the bile method did not last long and its administration in many cases caused death. The bile obtained from the cases found in the field was found to be either too virulent or too weak. This method was employed about 1900–1901.

Under the same Board of Health an antiplague and vaccine serum institute was established in 1901–02 and since the bile method was not giving the expected results anti-rinderpest serum was also produced at this institute. It was first used on the imported cattle which certain persons were beginning to import from the Chinese coast in the latter part of 1902. On January 1, 1903, the serum laboratory of the Board of Health having been transferred to the Government Laboratories, the immunization by the simultaneous method of all cattle in the vicinity of infected areas throughout the Archipelago was attempted by the agents of the Board of Health, Government Laboratories and Bureau of Agriculture. Marked succecs was first reported but heavy losses resulting from its use prevented its further employment on account of a strong local opposition. The failures were no doubt due to the fact that the virus used was taken in the field and consequently there was a great variability in its virulence. The low potency of the serum was also probably responsible for many of the failures. The varying susceptibility of animals in various places was not taken into account in giving the quantity of serum to be injected in each instance. The animals after injection were not held under control but turned loose in the fields and no attempt at taking temperatures was made with a view to controlling the reactions. The reason for this seeming laxity was the fact that a lot of the preliminary vaccination was perhaps done in localities where the disease had just passed and so most of the animals left were either naturally immune or had been through an attack of the disease.

But above all the fact was lost sight of, that the glycerinated bile method and the simultaneous inoculation method in which serum in doses of from 20 to 30 cc. was used amounted to giving the animals the disease. These methods gave good results where cattle were highly resistant, as those of Egypt, certain portions of British India, China, and Manchuria. In the Philippines the disease was of relatively recent introduction and the animals had not then developed high powers of resistance to the disease, as had the cattle in those places where the disease had existed for over a hundred years.

This method was abandoned for a short time in 1903 and serum alone was employed to stop the spread of the disease. A modified method was used whereby animals in an infected herd were first injected with serum alone, and later after an interval, given straight virus. The animals in clean herds were immu-

nized by the simultaneous method. But this policy did not last long on account of the strong opposition to it of the men engaged in the work themselves and the public.

Up to March, 1904, the field force composed of veterinarians and inoculators engaged in inoculation work were under the direction of the director of the serum laboratory. On that date a veterinary division was organized in the Board of Health with a chief veterinarian as its head. This arrangement lasted but a little over a year, for on October 19, 1905, the Philippine Commission passed Act No. 1407 which provided for the transfer of said division from the Board of Health to the Bureau of Agriculture. In the latter bureau the veterinary corps was taken into the Division of Animal Industry.

On January 1, 1907, the manufacture of rinderpest serum in so far as the care of the herd and immunizing the animals were concerned was delegated to the Bureau of Agriculture. The centrifuging, filtering, bottling, and testing of the serum were still done in the Bureau of Science (formerly Government Laboratories.)

Towards the latter part of 1907 and during 1908 the records indicate that no more immunizing was being done in the field but only at the San Lazaro detention station, where the serum was manufactured before the laboratory was transferred to Alabang in October, 1908.

The method of fighting the disease after the transfer to the Bureau of Agriculture of the Veterinary Division remained the same, reliance being put on the anti-rinderpest serum, injected mostly alone and on a very limited scale simultaneously with virulent blood. The use of the two methods as indicated was continued in 1906. As a rule the inoculating was done only in the infected places owing to the limited quantity of serum available. During this period the largest amount of serum manufactured in the fiscal year ending June 3, 1910, was 10,145 liters.

Quarantines were also instituted in the towns and left in the discretion of the local officials even from the first time that the Government took cognizance of rinderpest.

However, about 1909 and 1910 absolute quarantine was mentioned as a key to rinderpest eradication. It was found by actual field experience that the more perfect the quarantine was the shorter was the course of the outbreak.

During these years the serum method was still being used in the field but local and general quarantines which the increase of personnel had made possible were being employed. It be-

came evident that the control of the movements of animals between towns and between provinces aided very markedly in the prevention of the spread of the disease. The more strict the quarantine was the more marked were the satisfactory results obtained. Besides the local police the Constabulary were used in larger numbers as the satisfactory results became evident.

The unit of quarantine was the barrio, where the animals were tied up and kept separate from each other, and inspected by the inoculators assisting the veterinarians at frequent intervals to observe the animals injected with serum and discover any animal that might be coming down with the disease. The sick animal was removed to a corral constructed for the isolation of attacked animals. The place from which the case was removed, the premises, with the buildings and fences were disinfected with carbolic acid solution. Provincial and municipal officials were compelled to take an interest in the animal disease control work. Municipal ordinances and provincial resolutions were passed for the enforcement of quarantine measures with a view to controlling the spread of the disease.

During the fiscal year 1910–11 this method was given more extensive application, while companies of Philippine Constabulary were employed over entire municipalities. For the best results the concentration of personnel and troops over a certain given area was undertaken and for this work the municipal police were found inadequate and even the constabulary did not suffice. So in the campaigns in Pangasinan and Occidental Negros 1,200 scouts, 41 cavalrymen, and 5 veterinarians were detailed by the Army with the Bureau of Agriculture. At this time the value of anti-rinderpest serum as a means of eradicating rinderpest in a given territory was seriously questioned, for infection and reinfections persisted. It was believed that by quarantining, that is, separating exposed animals one by one, and immediately reporting the cases at the earliest onset of the disease over a large enough portion of infected territory in a systematic manner, large tracts could be permanently freed from the disease. Experiments on the efficacy of anti-rinderpest serum done that year proved that the serum alone method conferred but a short period of protection, not more than 14 days. Inasmuch as it could not be produced in sufficiently large quantities for all exposed animals in the infected provinces which involved the very important provinces in Luzon and Panay, and the Province of Cebu, and because it would have been neces-

sary to reinject the animals every fourteen days, the amount of serum and labor needed would have been enormous.

Slaughtering was done in a tentative and experimental way. It was thought that the offer to pay for sick animals would encourage owners to report cases but it did not give the desired result as it resulted in putting the rest of their animals under quarantine and also for sentimental reasons. Owners did not want to see their work animals slaughtered. It was decided, therefore, to definitely adopt the method of eradicating rinderpest by the quarantine alone method, and using the money heretofore employed for making serum to hire inspectors.

To carry out this new method, a plan was worked out which was in a way a refinement of that used since 1909 and 1910 in a restricted way. This required a great concentration of forces—veterinarians, inspectors, and soldiers. These men were instructed in the new way of handling the disease, its purpose and objectives. In the occupied territory all carabaos and cattle were tied up apart from each other, subjected to a daily scrutiny and those developing disease were immediately placed in quarantine corrals constructed in suitable places. Usually one in a barrio was sufficient.

At the beginning of the year 1911 rinderpest was not doing much damage and the disease was found in a mild form principally in central Luzon and Occidental Negros. Attacking the disease as it broke out in various scattered places was resorted to although reduced losses did not give permanent results, for foci of infection still existed in a scattered manner and infection was thus kept smouldering and if introduced in a place where the disease had not existed for several years it would cause several outbreaks. The death rate in these places where the disease existed mostly scattered but in a mild form was from 30 per cent to 50 per cent, whereas in those places which had been free for several years if the disease was again reintroduced the death rate would be nearly 100 per cent because in the former the old animals left were the survivors of former outbreaks, and consequently the most resistant ones, while in the latter the new animals were the susceptible ones. The concentration was started with the idea of wiping out these foci of infection beginning with Pangasinan and Occidental Negros. The method employed was the following: All municipalities were obliged to keep a census of all their animals. The veterinary quarantine force was composed of veterinarians, livestock

inspectors and the necessary troops, which were thrown into the area that was to be occupied. The unit of the territory to be occupied was the municipality, and when enough soldiers were available as many as four municipalities were occupied. The soldiers were placed in and around the municipalities in posts or cordons as the case may be to insure that no cattle, carabaos, swine, deer, sheep, or goats were taken out of the place, using the animal census of each municipality as a basis. A more exact census of the carabao and cattle population by sitios and barrios was prepared. As a rule where this census was completed about ten per cent more animals were encountered as compared with the number shown in the census prepared by the municipality. It was then required to have the carabaos and cattle tied up about 20 meters apart in individual enclosures made of bamboo and roofed over with cogon grass. Small holes were made near the animals for the disposal of excreta that could not be burned. The animals were watered and fed here for the period of observation, which lasted fifteen days. During this time they were inspected every day. If infection was encountered the municipality was held under quarantine for thirty days after the last case was registered. The general quarantine, as it was sometimes called, was started in Luzon Island from Pangasinan and from there it was extended south through the Provinces of Nueva Ecija, Pampanga, Bataan, Bulacan, and Rizal by the middle of 1912. The territory which had been cleaned was guarded against reinfection from the north. At the boundary line between Pangasinan and La Union a scout patrol was maintained for a long time, after which a fence was constructed from the seashore at Kaba to the foot of the hills near Rosario. A launch patrolled the coast of Lingayen gulf to prevent any clandestine shipment of animals into this territory.

Northward from Pangasinan the rinderpest quarantine forces had moved through La Union, into Ilocos Sur, as far as Laoag, on to Solsona and Dingras, Ilocos Norte, about the latter part of 1913.

In the Visayan Islands also several companies of troops were utilized in reinforcing quarantine in the infected municipalities. These were in Capiz, Iloilo, Antique, Negros Occidental, Bohol, and Surigao.

The progressive search method whereby it was hoped to clean a given territory and keep it clean afterward was not meeting

with a full measure of success, for soon reinfection was encountered in the cleaned territories on account of filtration of animals from infected places, as the absolute stoppage of clandestine movements of animals could not be had. Wild hogs and deer were likewise responsible for reinfection in those places near mountains and grass plains. Besides atypical cases of rinderpest were encountered which in some instances had been passed over and became foci of infection after the animals were released from quarantine. At that time since much larger parts of Nueva Ecija, Pangasinan, and Tarlac in central Luzon and the northern part of Ilocos Norte were waste land, a complete muster of animals was out of the question.

Although rinderpest in the Philippines is of relatively recent introduction, it had spread to nearly all places, especially in Luzon Island, including the Mountain Province where this system of controlling the disease could not be adopted. So, about the end of 1913, it became evident that some other means combined with quarantine was needed.

The old simultaneous method with a certain modification was determined upon. This modification consisted in having the animals stabled in temporary sheds, where they could be closely watched and cared for, so that their temperatures could be taken daily and thus their temperature reactions detected early and controlled by the injection of more serum. This particular modification was not a new one for it was practiced for the first time in the old serum laboratory, but it had never been adopted as a field measure. The fact, observed here and elsewhere, that the serum taken from an animal that had gone through a good reaction of the disease was as good as the serum taken from an animal that had been hyper-immunized, was taken advantage of to make this modified simultaneous inoculation a practical, cheap, and safe method of immunizing. The idea was to recover the serum from the immunized animals, so that after the first few batches of animals had been immunized no more serum need be sent out from the laboratory in Manila. This was first tried with a bunch of carabaos belonging to the Calamba Sugar Estate and intended for shipment to Calamba, Laguna Province. The dosis of serum was determined by trial injections and when the proper amount had been determined the inoculation of the rest followed. The animals were given sufficient serum so as to minimize, and if possible, prevent losses, which in this instance were a little over 1 per cent. The period of

immunization was twenty-five days, after which the immunized animals—reactors and non-reactors—were bled from 2 to 3 liters of blood before they were released to recover the serum used, excepting only the very old, and very young animals, and those heavy with calf.

After the first three batches the serum used was all obtained from the immunized animal in the field. When the immunization work was under way the virus was taken from reacting animals, usually on the third day of febrile temperature. The virus thus obtained was examined for surra and other blood parasites before use.

The sheds used for the animals, and sheds used for laboratory where the serum was poured and where the animals were bled were made of bamboo and grass, enclosed by a bamboo fence.

Under these field conditions the blood was drawn into one-liter flasks containing a small quantity of citrate solution. The bottles were allowed to stand until the blood coagulated, and the serum was drained off and stored in demijohns without any further centrifuging and filtering. It was found that the serum produced under these conditions kept well for several weeks. A five-tenths per cent carbolic acid solution was added to the serum as preservative.

The sheds were constructed by the owners of animals themselves, who looked after their own animals during the period of immunization, so that during the immunization work done in Ilocos Norte from October, 1913 to the middle of 1914, the only expenses borne by the Government for this work were the salaries of personnel, and those for traveling, and the cost of the few simple equipment used. This saving on the serum alone amounted to many thousand pesos.

At the beginning of the year 1914, some radical changes were made in the manner of enforcing general quarantines besides completely abandoning the use of troops, excepting the municipal police or small forces of Constabulary soldiers in cases where the disease got very bad. This was because the Government could not keep up for a long time the heavy expenses necessitated by the employment of a large force of inspectors and soldiers. The Insular Government paid the traveling expenses and per diems of the officers and men used in the campaigns of progressive search and quarantining of infected places. Over and above this the people got tired of having

to confine their animals, feed and water them, and to have to round up large herds in order to corral them.

It was not long before the representatives in the Legislature took up the matter, and amended Act 1760 by passing Act 2303, which provided that the Director of Agriculture shall draw up the rules and regulations for the handling of contagious and communicable animal diseases, and that the provincial governor shall have the direction and the responsibility for the enforcement of the same. On the passage of this Act a set of rules and regulations were prescribed for the isolation of the affected animals and the quarantining of all exposed ones susceptible to the disease, which were, on the whole, similar to those previously used with the exception that smaller areas were included in the quarantined zones. These consist ordinarily of the infected barrios and the adjoining ones. With the reduction of the force of veterinarians and inspectors very few men were left in the infected provinces. The veterinarians were converted into mere advisors to the provincial governors. In some instances the provincial boards were persuaded to appoint provincial inspectors. From time to time, in places where the disease got to be very bad the Insular Government was forced by circumstances to take the situation in hand by putting in more men and practically directing the campaigns. This arrangement still holds, and a very effective quarantine can not be maintained because people will not voluntarily submit their animals to quarantine and municipal officials being elected officers cannot very well enforce quarantine measures without becoming unpopular. The force available has always been inadequate and, although spasmodically increased during very severe outbreaks, it has to be reduced again after several months when the money runs out as it always does. In the year 1922 a vaccine developed by the Veterinary Division of the erstwhile Bureau of Agriculture was pronounced safe enough for field use in large quantities and local quarantines from then on received an effective support.

With the change in the method of establishing quarantines, as before stated, because of the apparent failure of the quarantine alone method due to the impossibility of rounding up all the susceptible animals in an unfenced country with many large tracts of unsettled grass land and mountainous regions where wild hogs and deer and half-wild cattle run at large, the need for biologic agents to be used in combination with quar-

antines became more pressing. The experience had in Ilocos Norte with the modified simultaneous inoculation method gave promise that this method could be more extensively employed. So an immunizing station was established in Iloilo, and another in Pandacan, Manila. These were, however, primarily for the immunization of carabaos imported from French Indo-China, for the sugar haciendas of Occidental Negros and other places. In these two stations the serum used was manufactured at the laboratory and the importers or owners of the animals paid for it and other expenses.

The Provincial Board of Pampanga later requested the establishment of an immunizing station at Mexico under the same plan and method of immunizing as that used in Ilocos Norte. This station had to be closed when most of the animals in this municipality had been inoculated. Furthermore, because of the lack of a compulsory law, the people could not be compelled to have their animals immunized.

In Ilocos Norte, after all the soldiers were removed and the majority of animals in Laoag, Solsona, and Dingras were immunized, the work had to be suspended about the middle of 1914. With the removal of the troops, and because of the mild form of the disease then prevalent in Ilocos, the people gradually ceased taking their animals to the immunizing stations. The trouble it entailed also in caring for their animals for the period of 25 days or more and the deaths caused by the immunization though insignificant in number could not be considered by the ordinary countryman but a great calamity. He preferred to take his losses in the natural course of events, and not through the artificial infection of the animals.

Because of the prevalent disinclination of the people to bring their animals to the immunizing stations, as experienced in Ilocos Norte and Pampanga, the necessity for a law which would make immunization by the simultaneous method compulsory became apparent, and on January 17, 1916, the Philippine Legislature enacted Act 2548, which besides appropriating a sum of money provided that whenever the provincial board of an infected province, by resolution, had decided on the immunization of cattle and carabaos, the Director of Agriculture was authorized to enforce compulsory immunization. The provincial board paid the rent of the site of the immunizing stations and the expenses for the construction of sheds for the animals and temporary buildings, salaries of laborers, and other run-

ning expenses. The Insular Government furnished the veterinarians and livestock inspectors. The income of the province consisted in the fee charged, which was ₱3 per head. The central Government appropriated an insurance fund for the purpose of paying for the animals dying as a result of the simultaneous immunization. The amount paid was 75 per cent of the appraised value of the animal. This system of immunization was practiced until the close of 1922, or for a period of six years as a field measure in controlling rinderpest. The provinces where it was tried were Pampanga and Batangas.

Nothwithstanding the indemnity offered it did not become very popular on account of the length of time the animals had to remain at the immunizing stations during the process of immunization, which was thirty days. Although the operations were carried on during the time of the year when planting or harvesting were over, still the farmers did not care to be interrupted in the routinary work of their farms. Besides, they strongly objected to the bleeding of their animals of several liters of blood to recover part of the serum used. Although this did not materially affect the animals' health, it weighed heavily on the farmers' mind. This had to be insisted upon, however, otherwise, the cost of the serum would have been prohibitive.

The rinderpest situation in the year 1922 was serious, for the cases and deaths had been increasing ever since the relaxation in 1914 of the very strict quarantines. So by 1922 it was clear that having immunizing stations as a field measure for the control of rinderpest was too slow a process and was not meeting with favor with the people. Therefore, the infection having penetrated into every nook and corner of the Islands excepting a few isolated islands, a new method of control had to be found. The quarantine method, however, was persistently employed in the face of the opposition, many times, even of local officials as the only known measure to minimize losses and prevent reintroduction of the infection in those islands already freed from the disease. In spite of handicaps periodical outbreaks of the disease were checked and losses very much minimized by its employment. In fact, notwithstanding the prevalence of the disease, the yearly increase of cattle showed a gradual gain on the losses.

Beginning in 1910 research work was carried on on rinderpest with a view to finding a satisfactory preventive prophylactic

treatment. Fortunately the long years of research had given fruit in the form of a vaccine which in 1922 was in shape for field use on a big scale. At first used in three doses, injected at an interval of a week between injections, it was gradually perfected so that in 1928 a vaccine was produced which conferred immunity with one single dose. Although the immunity is not lasting it can favorably be compared with hemorrhagic septicemia aggressin in efficiency. This vaccine does not cause severe reactions, provided it is not released for use in the field until it has been thoroughly tested in the laboratory.

Its use for the last seven years has given a marked improvement in the rinderpest situation. By means of it the infection has been driven from the plains and confined to mountainous regions. At this writing the only infected places are the souththern portion of Occidental Negros, Mountain Province, and the swampy region between Nueva Ecija, Pampanga, and Tarlac where the muster of animals in vaccination drives fall below 50 per cent of the animal population. This vaccine has to be kept on ice constantly until a short time before its use; hence the difficulties met with in remote places.

The following table will show the approximate incidence of rinderpest from the year 1900 to the year 1929 and the steady decrease of cases and deaths since the employment of the vaccine.

Year	Cases	Deaths	Total immunized with rinderpest vaccine		Cattle doses of rinderpest vaccine	Remarks
			Three injections	Single injection		
1900–01		35,840				
1901–02		50–60%				
1902–09	8,605	6,128				
1909–10	10,066	7,860				
1910–11	8,438	5,500				
1911 [a]	2,516	1,764				
1912	3,082	1,830				
1913	4,972	2,986				
1914	3,940	2,715				
1915	3,631	2,305				
1916	23,808	18,251				
1917	38,971	26,951				
1918	21,586	15,747				
1919	16,228	11,285				
1920	22,442	16,911				
1921	45,380	35,740				
1922	45,683	34,306				
1923	27,505	23,220	14,778		44,335	Three-injection method.
1924	19,599	15,350	95,038		285,098	
1925	14,143	10,747	95,380		286,141	
1926	9,824	7,470	132,376		397,128	
1927	3,013	2,123	132,491		397,478	
1928	3,650	2,692	34,017	89,214	249,893	Single-injection method.
1929	3,913	2,883		194,081	355,071	Carabaos received double the cattle dose. Up to November 23.

[a] From July to December only.

The figures given in the preceding table do not represent the actual number of rinderpest cases and deaths. Many more must have occurred which were not found and reported, but they will serve as an index. The figures given from 1900 to 1911 are the earliest figures available and they are given as originally compiled in fiscal years beginning with July and ending June 30. The others have been reduced to calendar years to conform with the latest reports, beginning with 1914, when the fiscal year was made to agree with the calendar year.

It will be seen that in 1916 the number of cases began to increase, and that with the employment of the rinderpest vaccine a big drop in the number of the cases and deaths took place. This vaccine is still susceptible of further improvements but as it is, at present, it promises to keep the rinderpest down to the minimum until the Islands are more closely settled, when complete eradication will become a possibility.

ARAB, CROSSBRED AND PHILIPPINE HORSES

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THIRTEEN PLATES

The origin of horses, including Arabs, has always been more or less a debatable question among scientists until comparatively recent years. Much painstaking research work has been done to solve this age-old question and the conclusions arrived at and generally accepted as being the most logical will presently be briefly summarized from that valuable work compiled by the late Captain M. H. Hayes, the "Points of the Horse."

In the Amherst College science laboratory, Amherst, Massachusetts, there are five mounted skeletons of horses, depicting five very distinct stages in their evolution.

The first one is a tiny animal eleven inches high and having four toes on its front feet and three and a fraction of a fourth toes on its hind feet, konwn as the *Eohippus*. The second horse had three toes, all touching the ground when it walked and was about as large as a Collie dog. The third horse had toes, but the side ones did not touch the ground. The fourth horse lost his side toes during the process of development and had only "splints" (known to anatomists as small or rudimentary metacarpals) remaining to represent the instep portion of the toes. The fifth and largest skeleton of the horse is as we know him today. It is estimated that it required six million years to accomplish the evolution in the words of Major General William Harding Carter, U. S. A., in "The Horse of the World" number of The National Geographic Magazine, December, 1923.

It appears from the authoritative work of Captain Hayes that the ancestors of the horse were evolved from the three- to one-toed form that emigrated from North America into Asia during the Great Ice, or Pleistocene, Age, before the subsidence of land that is now covered by Behring Strait and by the Sea of Kamtchatka, and that none of the animals ever returned by natural means over that route.

It is further stated in substance by the same authority that the ancestors of all living horses were inhabitants of Siberia after their emigration from North America, and as Siberia is closely connected with Mongolia it is reasonable to infer that the Mongolian ponies (known in Manila as Chinese horses) are nearer the original type of horses than any other domesticated horse. From Asia the horses migrated to Europe and in all probability from Europe to northern Africa.

He further says that there are two living varieties of horses that have never been domesticated, i. e., the Prjevalsky and the Tarpan. The former were named after a Russian traveler and made their home in a limited area south of the Altai Mountains. Their usual heights varies from 12 to 13 hands, or 48 to 52 inches.

The Tarpans, on the other hand, are found in the steppes of Siberia and Central Asia and a part of the southeast of European Russia. They, too, are ponies and can be handled only with difficulty if captured even when they are very young.

It is generally conceded, by competent authorities, that neither one of these two kinds of wild horses or ponies have ever been transmuted by crossbreeding.

The most remarkable thing, among the many, in the evolution of the horse, which is now generally believed to have originated from the one species, is the extreme variations in size and conformation, from the small Korean ponies which may not exceed nine hands (36 inches) in height to the large draft breeds of horses that were developed in Europe and may weigh a ton, or more, and stand 17 hands (68 inches) or more, in height. Scientists attribute the cause very largely to the difference in latitude, as it has been observed that when horses and certain other animals are removed, in either direction, from a certain latitude they deteriorate quickly and markedly in size. Other contributing factors are food, and uncontrolled, or improper breeding.

ARAB HORSES IN INDIA

If the evolution of the horse, as related, is correct, the Arab horse is a descendant of the Mongolian ponies that evolved from the primitive horse that emigrated from North America during the Pleistocene Age.

It remains a moot question with researchers whether or not it migrated to Arabia from the Libyan desert of northern Africa

through Egypt, or direct to Arabia. The former theory is the generally accepted one.

The horses known as Barbs, sometimes called Arabs, come from Morocco, Algiers and Tripoli. They were interbred, in former times, it is said, with imported Syrian Arabs. While they are ordinarily larger than Arabian-bred horses they are generally considered, by expert horsemen, to be inferior in quality. The ideal height for Arab horses, with most people, ranges from 14 to 14½ hands, or 56 to 58 inches.

There are several very distinct types of Arab horses in Arabia which may be attributed, very largely, to the latitude, soil and food of the locality from which they come and, to some extent, to a limited selection in breeding. The prevailing colors are chestnuts, bays, browns, iron greys, flea-bitten greys and dapple greys, the latter one turning white with age and the iron, and flea-bitten, greys partly so. Solid colors, however, are rather rare.

It is said by some authorities that a considerable number of horses imported into India as Arabs come from the districts adjoining the Euphrates and Tigris Rivers, i. e., Al Jazira, Araq, etc. On the other hand it is alleged, by equally competent authorities, that many of the best and highest caste Arab-bred desert horses are frequently sent to India for racing purposes. The truth would seem to be that both kinds are sent to India as well as many very ordinary horses that are sold for public streeters.

All Arabian horses that enter India do so through the port of Bombay, after having first passed a satisfactory mallein test for glanders administered by the port veterinarian.

Those that are for sale are then taken to commission sales stables and the most promising looking animals for racing purposes are bought by dealers who condition and train them for racing. Such animals as are finally selected for racing purposes are then aged and registered by the Western Racing Turf Club, Ltd. The nondescript animals are generally sold for *gharry* and *tonga* work.

Bombay has a splendid race course, with very modern buildings and beautifully kept grounds, which is more or less true of nearly every city and town of any importance or size throughout All-India.

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The races are well patronized by all classes of natives and Europeans and are held in some part of All-India for at least six months during the year.

The Arab ponies, as they are called in India, race in their own classes, as do thoroughbreds that come from England, Ireland, France, and Australia race in their class.

After the racing season many of the Arab stallions are sold to the Imperial, State or provincial, governments for breeding purposes. The Japanese government also purchases quite a number of them for exporting to Japan for use at the remount breeding stations.

There are no reliable records kept of their breeding and therefore pedigrees for Arab horses are not available. There are many splendid specimens of Arab horses to be found in India and the prices for those that are good enough for racing or breeding purposes will vary ordinarily from about *rupees* 1,500 ($555) to *rupees* 7,500 ($2,775). Exceptionally good Arab race horses may sell, however, for much more money, depending very largely upon what is believed to be their future possibilities as race horses.

With the exception of the Arab mares imported by the British government for breeding purposes, at their remount breeding stations, there are but very few mares imported as it is said that the Arabs ask very fancy prices for them and are reluctant to part with them at any price. Until very recent years the Arabs attached more importance to the ancestral qualities of the dams of their horses than to their sires. This condition is rapidly changing and much importance is now being attached to the qualities of the sires as well as the dams. Ancestral records or Stud Books are now being kept in certain localities with the object in view of furnishing reliable pedigrees for animals having the necessary qualifications for registration.

The writer saw at the Ahmednager Stud in the Deccan colts that were sired by Arab sires having thoroughbred dams and by thoroughbred sires having Arab dams that could not be differentiated as to size for their corresponding ages.

ARAB HORSES IN THE PHILIPPINE ISLANDS

After civil government was established in the Philippine Islands and since the year 1902, twenty-five stallions only, other than native ones, have been acquired by the Insular Government for breeding purposes. Of this number six were from the United States and were either standard-breds or thorough-

breds; two were Welsh ponies from Australia and seventeen were Arab horses. Three of the latter were donated by His Excellency W. Cameron Forbes, former Governor-General of the Philippine Islands and now Ambassador to Japan.

These horses were sent to various parts of the Islands for crossing on native mares. On the whole they sired a few colts, but they all died, sooner or later, and no material results were obtained from them, for the reason that the work was not consistently followed up with replacement stallions, when the original stock died or was removed.

At the Alabang Stock Farm, however, a nucleus of halfbred Arab and Welsh pony fillies has been formed, the progeny of Arab stallions and one Welsh pony formerly stationed there.

In 1929 six head of Arab stallions were imported from India and one Welsh pony from Australia. The fillies at the farm are being mated now to their respective breeds, the Arabs to the two purebred Arab stallions shown in Plates I and II and the halfbred Welsh mares to the purebred Welsh stallion.

Two other purebred Arab stallions (see Plates III and IV) are being used at the Bureau's Breeding Station in Batangas, Batangas, and one (see Plate V) at the Bureau's Breeding Station in Cebu, Cebu, while one (see Plate VI) is unassigned.

The halfbred brood mares and fillies at the Alabang Stock Farm (see Plate VII) live very largely on local pasturage, with little or no supplementary food.

As there were no Arabian stallions, for a number of years, for replacements of those that died at the out stations the progeny, from the halfbred mare colts that were sired by the Arabian sires, soon reverted back to the native animals. The same statement applies to the halfbred thoroughbreds and standardbred mare colts.

The first cross, Arab or Welsh ponies having native dams have proven their ability to live on local pasturage with little or no supplementary feed. The promising looking halfbred Arab-native horses find ready sale at very good prices for driving or racing purposes, as they are larger and "breedier" looking animals than the average run of native ponies. (See Plate VIII.)

If it is the intention to upgrade to a pureblood of either the Arab or Welsh breed, the second cross would be a three-quarter bred, the third cross a seven-eighths, the fourth cross a fifteen-sixteenths, and the fifth cross a thirty-one thirty-second, or technically a purebred Arab or Welsh, depending upon which was used. It remains to be seen whether or not all of the cros-

ses will live on local pastures with no, or very little, supplementary feed. If they will, then something worthwhile will have been accomplished.

Ordinarily the first cross between two different breeds of animals is the best one. From the first to the fifth cross there is a long stretch and all sorts of variations in the conformation of the crosses may be expected, as they are in betwixt and between the two original breeds. However, variations are to be expected in upgrading any class of animals from two breeds to one breed, for the reason that the intermediate crosses are neither breed and, therefore, they are not of a fixed type and have not the ability of transmitting their likeness regardless of the type of animals they are mated with.

In order to accomplish any tangible results in livestock breeding by the upgrading method, of any kind of animals, there must, of necessity, be continuity of purpose and sustained competent supervision. If not, all money and efforts expended will go for naught.

PHILIPPINE PONIES

The Philippine pony has no superior for his inches. Unfortunately it does not have more inches, as they will average less than 50 inches. Notwithstanding their small size their stamina and their endurance are remarkable and unbelievable to people who are not familiar with them.

It is nothing unusual for a Philippine pony that is not more than 48 inches, or twelve hands, to carry a man weighing 150 to 160 pounds over mountainous regions, and difficult trails, all day and to repeat the performance the following day or days, with nothing to eat in the meantime except wild grass that may be growing along the trail when staked out at the lunch hour and during the night.

The origin of the Philippine pony is somewhat obscure, but it is suspected that he was brought into Sulu, before the advent of the Spaniards, quite possibly from the East Indies, where he has an almost exact prototype in the Battak pony. It is believed, in some quarters, that their common origin was the Arabian strain of the Mongolian horse.

The difference in latitude, soil and food may explain the difference in size of the Arab and native ponies although originating from the same species.

Don Antonio de Morga, Lieutenant Governor-General of the Philippine Islands from 1595 till 1603, states in his "Sucesos de las Islas Filipinas" that the first horse which was a Mongolian

horse was brought into the Islands from China in 1574, by *Capitan* Juan Pacheco Maldonado.

If the origin as related of all living horses is correct, i. e., from the prehistoric North American horse that emigrated to Siberia thence to Mongolia, Europe and northern Africa and from these two latter countries gradually to other parts of the world then they must have descended from either the Asian, European or north African strain of the Mongolian horse, or in a more direct route from Mongolia. The question is as academic as the age-old one of whether the hen came first or the egg came first.

The native ponies vary in color, with bays and greys predominating and there are some very fine specimens among them. (See Plates IX and X.)

They are not heavy enough for agricultural work or strictly draft purposes and are seldom used in this sense. Their principal use is for riding or driving, and when for the latter they may move heavy loads if hitched to a two-wheeled vehicle, known locally as a *carretela,* if on metalled or improved roads.

It is doubtful if the pony would be as suitable for the United States, as is the Shetland, for the reason that it is too much horse for the average youngster and not enough horse for the average man.

The average first cross of Arab-native ponies, conservatively estimated, should stand about 53 inches and the second cross quite possibly 54 to 55 inches. (See Plates XI, XII, and XIII.)

By continuity of breeding and replacements of Arab stallions in the principal horse-breeding sections of the Islands it should be possible in the course of a few years to make available quite a number of Arab crosses which very possibly would subsist on the country.

Such horses should be very satisfactory in size for Filipino cavalrymen.

ILLUSTRATIONS

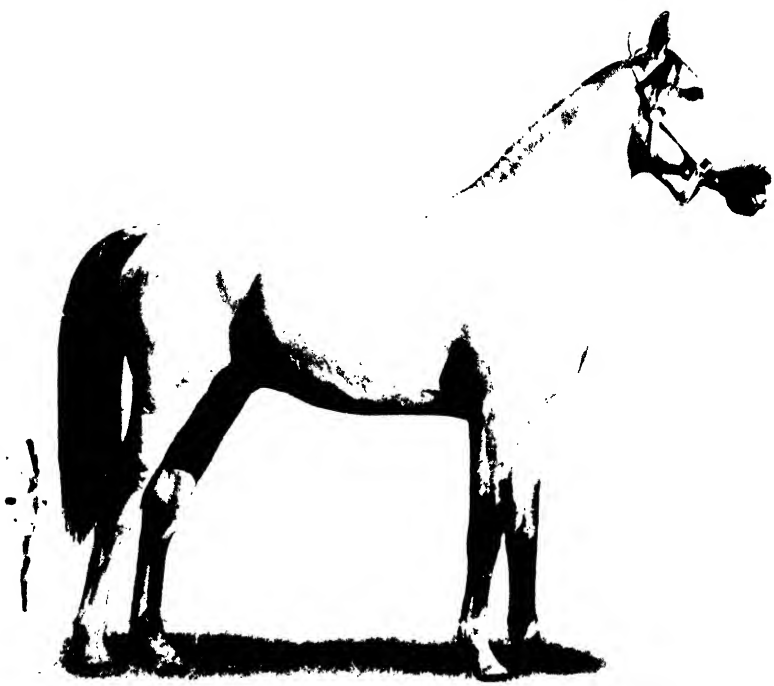

PLATE I. "Nuwara Eliya." Winner of the Roshun Plate, Madras, India, 1928. Distance: 1[illegible] miles. Purse: Rs 2000 (₱1,480). Height 58 inches, or 14 hands, 2 inches. Now kept at the Alabang Stock Farm, Alabang, Rizal.

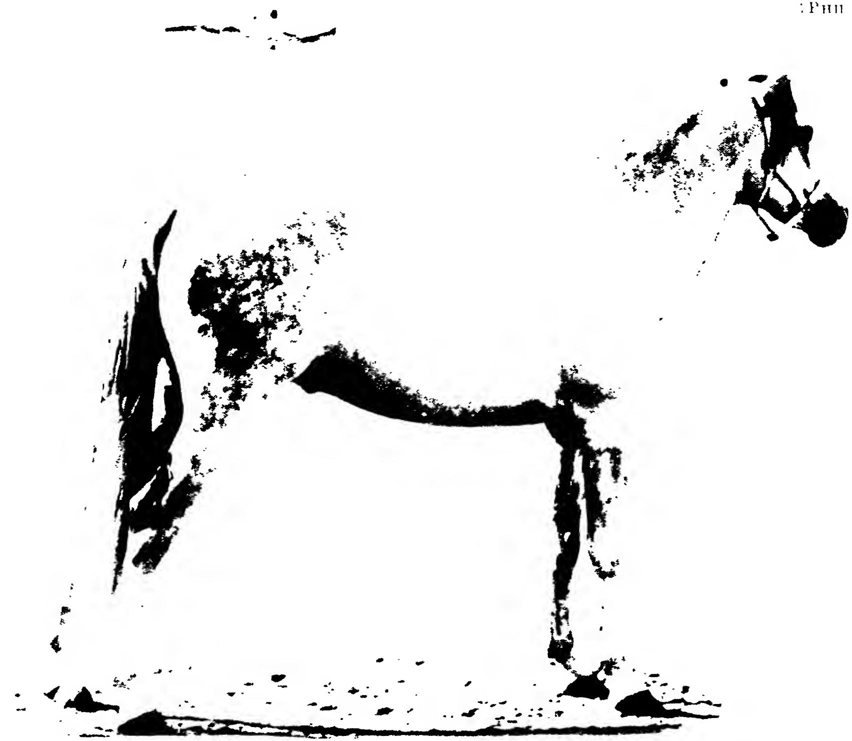

PLATE II. "Siberia." Height: 58½ inches, or 14 hands, 2½ inches. Kept at the Alabang Stock Farm, Alabang, Rizal

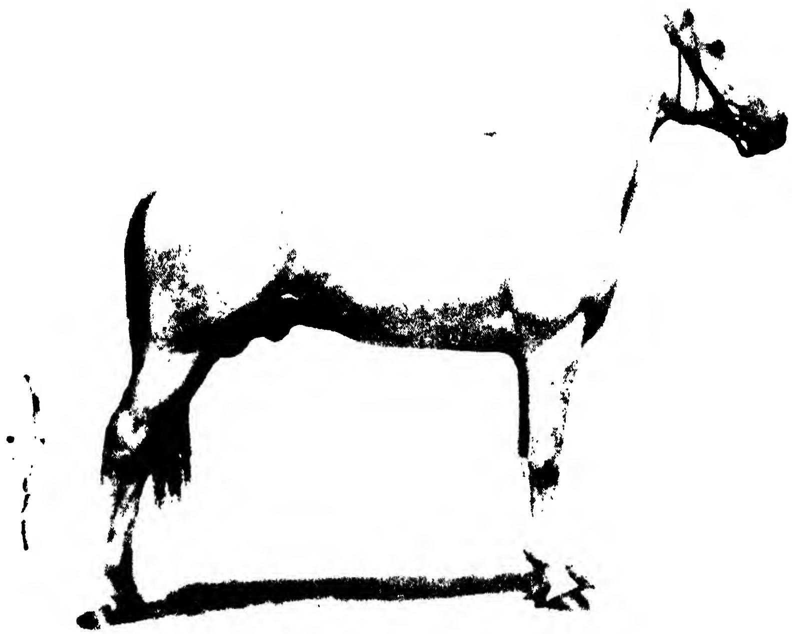

PLATE III. "Bella." Height: 57[illegible] inches, or 14 hands, 1[illegible] inches. Kept at the Batangas Breeding Station, Batangas, Batangas

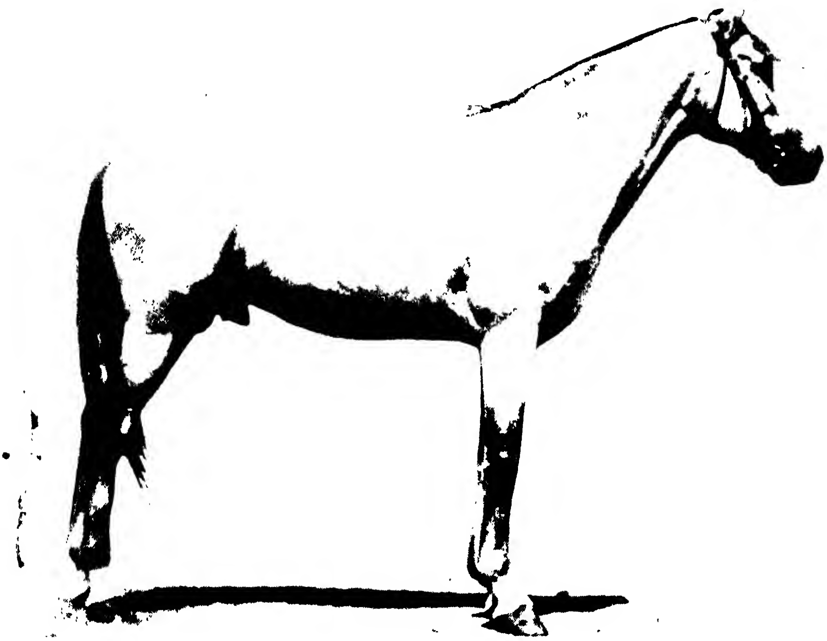

PLATE IV. "Viking." Height: 57¼ inches, or 14 hands, 1¼ inches. Kept at the Batangas Breeding Station, Batangas, Batangas

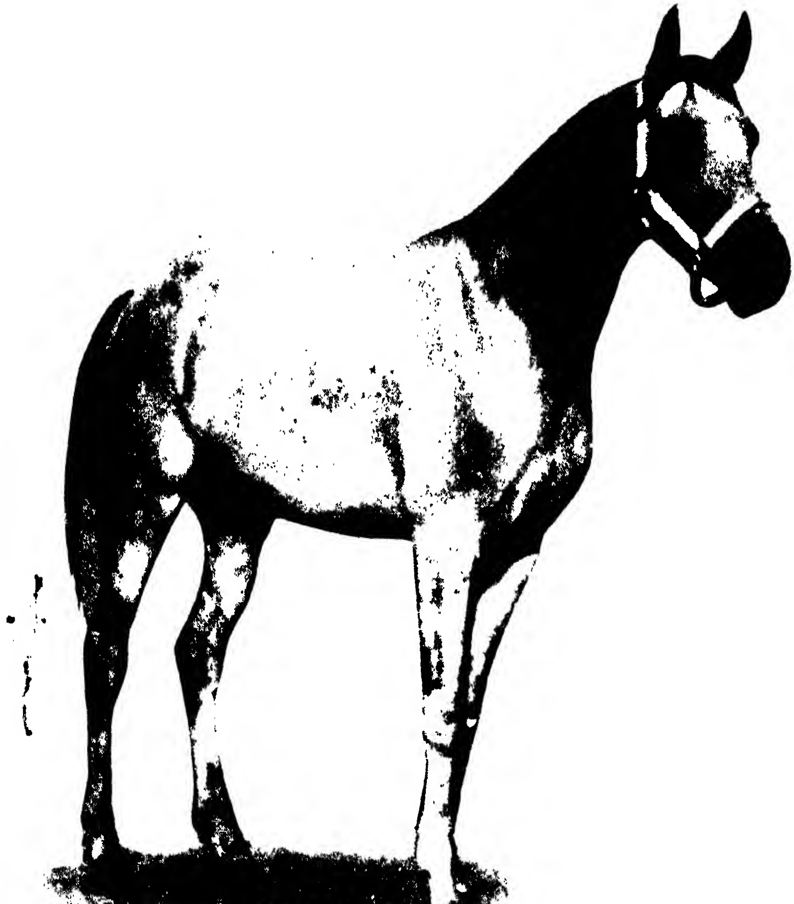

PLATE V. "Furdoon." Height: 58 inches, or 14 hands, 2 inches. Kept at the Cebu Breeding Station, Guadalupe, Cebu, Cebu

PLATE VI. "Pandil".- Height: 57¼ inches, or 14 hands, 1¼ inches. Kept at the Alabang Stock Farm, Alabang, Rizal

[PHIL. JOURN. AGR., I, No. 4, 1930.

PLATE VII. Halfbred Arab-Philippine mares and fillies. A nucleus of first crossbred Arab-Philippine mares and fillies, for upgrading purposes, born and raised, very largely, on local pasturage at the Alabang Stock Farm, Alabang, Rizal.

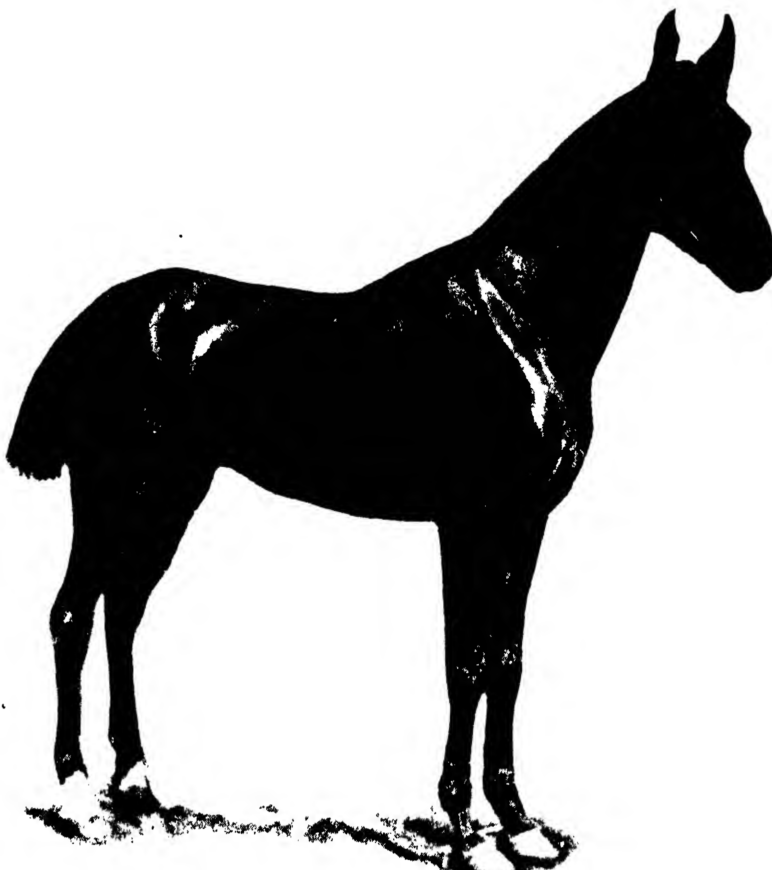

PLATE VIII. "Alabang". A halfbred Arab-Philippine horse, born and raised at the Alabang Stock Farm. Height: 55 inches, or 13 hands, 3 inches. Age: 3½ years. (Sold to Representative Cirilo B. Santos of Bulacan Province.)

PLATE IX. "Carbonero." A purebred Philippine pony, property of the erstwhile Bureau of Agriculture. Height: 54 inches, or 13 hands and 2 inches.

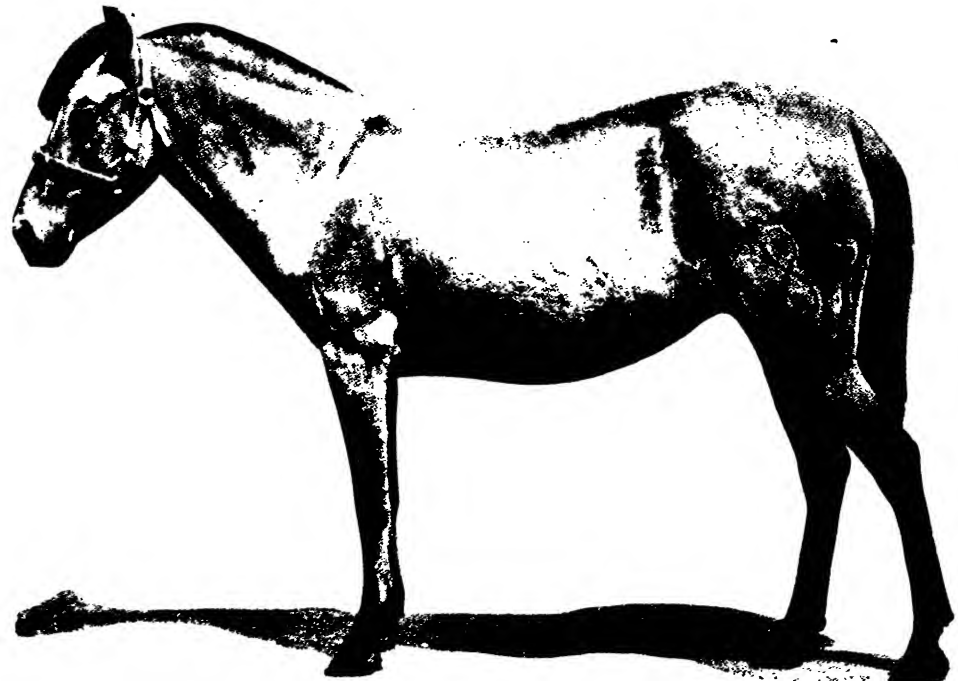

PLATE X. "Ulila." A purebred Philippine mare, property of the erstwhile Bureau of Agriculture

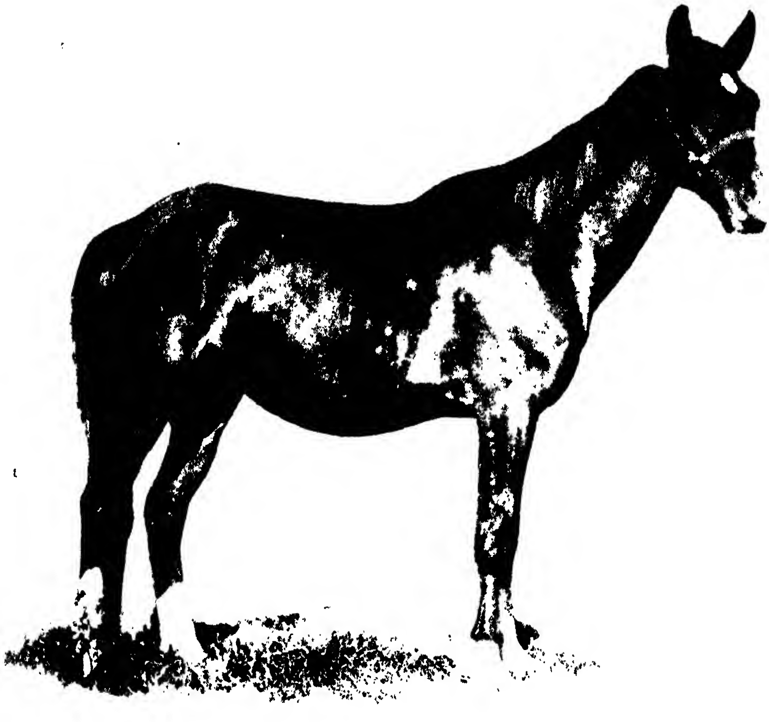

PLATE XI. "No. 741." A halfbred Arab-Philippine mare, born and raised at the Alabang Stock Farm. Height: 55½ inches, or 13 hands, 3½ inches. Age: 4 years and 5 months.

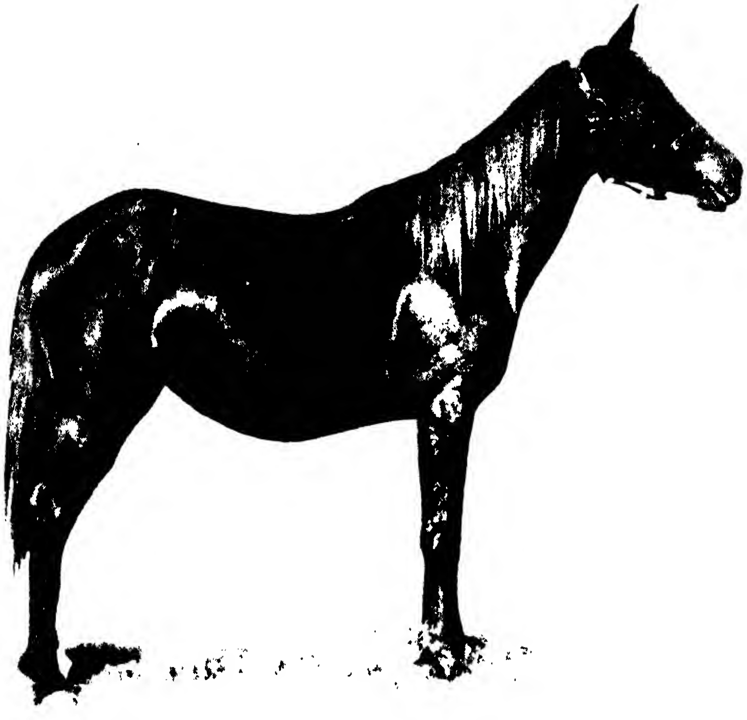

PLATE XII. "No. 746." A halfbred Arab-Philippine mare, born and raised at the Alabang Stock Farm. Height: 54[illegible] inches or 13 hands, 2[illegible] inches. Age: 4 years and 2 months.

PLATE XIII. "No. 769." A halfbred Arab-Philippine filly born and raised at the Alabang Stock Farm. Height: 52 inches, or 13 hands. Age: 2 years and 6 months.

TWO TAPEWORM PARASITES FROM THE CARABAO, WITH SPECIAL REFERENCE TO A NEW SPECIES OF AVITELLINA

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and

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TWO PLATES

One of us (E. C. F.) had occasion to examine the intestines of four carabao calves of about one-and-a-half years of age, that were sent from the Government live stock farm at Bongabong, Nueva Ecija, to the quarantine station of the Bureau of Animal Industry at Pandacan, Manila, to be vaccinated against rinderpest. The calves were to be sold for farm animals, after immunization, but a prospective buyer refused them because of their poor appearance. In spite of the fact that they were voracious feeders, they were stunted and looked very unthrifty. Their skins were rough and in several places presented chronic ulcerating vesicles. It was decided, therefore, to slaughter them for meat. Among the parasites collected from them were two tapeworms, both belonging to the family Anoplocephalidæ. One was a new species of the genus *Avitellina* Gough, 1911, while the other was *Moniezia benedeni*, a well-known parasite of sheep and cattle in many countries, but which is here reported for the first time from the Philippine Islands and from a new host.

MONIEZIA BENEDENI (Moniez, 1879) R. BLANCHARD, 1891.

This constitutes the third species of the genus *Moniezia* which has been found in Philippine domesticated animals, *M. expansa* (Rudolphi, 1810) and *M. trigonophora* Stiles and Hassall, 1893, having already been reported by Schwartz (1922) from cattle and sheep, respectively.

The members of the genus *Moniezia* are usually divided into three groups, depending upon the presence or absence of interproglottidal glands and the nature of these, if present; namely, the *planissima, expansa,* and *alba* groups. In the first group, in

which the interproglottidal glands are arranged in lines at the juncture of the segments, ten species have been described. According to Theiler (1924), however, the supposed distinguishing characters of each of the different forms are either not constant or grade into one another so that it is believed that they represent only one species. In view of this, the following are considered as synonyms of *M. benedeni*: *M. neumanni* Moniez, 1891; *M. planissima* Stiles and Hassall, 1893; *M. triangularis* Marotel, 1913; *M. conjungens* Sauter, 1917; *M. latifrons* Sauter, 1917; *M. crassicollis* Sauter, 1917; *M. parva* Sauter, 1917; *M. pellucida* Blei, 1920; and *M. translucida* Jenkins, 1923.

DESCRIPTION (BASED ON MATERIAL AT HAND)

Total length over 1 meter; proglottids much broader than long, maximum width about 22 millimeters. Head (Plate 1, Fig. 1) unarmed, 0.8 millimeter in diameter; suckers unarmed, rounded to oval in outline, 0.25 to 0.28 millimeter in transverse diameter. Neck short and thick or long and rather thin depending upon state of contraction; immature segments 0.04 to 0.30 by 1.5 to 6.0 millimeters, mature segments 0.50 to 1.45 by 6.0 to 20.0 millimeters, and gravid segments 1.00 to 1.45 by 20.00 to 22.0 millimeters in size. Genital pores bilateral, at anterior half of lateral margins of proglottids; they are very prominent on mature and gravid segments. At the juncture of the proglottids are the interproglottidal glands. These are cellular structures arranged in transverse linear series, each series varying in length from 0.3 millimeter in young male-mature segments to 1.60 millimeters in fully mature proglottids.

There are two pairs of longitudinal excretory canals, the external ventral and the internal dorsal pairs, all having irregular outlines. They are of about the same diameter in the head and neck regions, but more posteriorly the external pair become much wider, attaining a maximum diameter of 0.60 millimeter in the mature segments. The dorsal canals remain narrow in diameter throughout (about 0.03 millimeter). One pair of longitudinal nerves are present, one on each side external to the excretory vessels.

Male reproductive organs.—The testes are roundish to oval in shape, 0.06 to 0.09 millimeter in diameter, 500 to 700 in number in each mature segment, arranged in the form of a continuous band (Plate 1, Fig. 3). They are mostly confined

to the medullary region between the ovaries, only a few occurring posterior of, and external to, the latter. The vasa deferentia are coiled tubes lying dorsal to the ovaries; they run anteriorly, then posteriorly and finally follow an almost straight course to the corresponding cirrus sacs, passing dorsal to the longitudinal excretory vessels and nerves. The cirrus sacs (Plate I, Fig. 4) are pear-shaped, 0.32 by 0.12 millimeter in size, extending from the genital pores to very near the longitudinal nerves; each encloses a slightly convoluted cirrus.

Female reproductive organs.—There are two ovaries in each segment (mature) located immediately internal to the excretory vessels. They are reniform in shape (Plate I, Fig. 4) with the convex borders facing anteriorly, and are 1.20 to 2.05 millimeters in diameter. Each is provided with an oviduct that starts as a narrow canal but which soon becomes dilated to form a seminal receptacle. The latter is elongated, 0.60 to 0.75 by 0.15 to 0.20 millimeter in size and lies transversely over the corresponding ovary. It is succeeded by the vaginal canal, which passes in an almost straight line to its genital pore, passing over the longitudinal vessel and nerve. On the right side, the vaginae are ventral to the cirrus sacs, while on the left side they are dorsal to the cirrus sacs. The vitelline glands are immediately posterior to the ovaries, being lodged nearly within the concavities of the latter; they are roundish in shape, 0.45 to 0.60 millimeter across. The shell glands are between the ovaries and vitelline glands. The uteri are reticulate, the two uteri in a gravid segment being fused in the median line. The eggs are more or less globular in shape, about 52 microns in diameter and provided with a characteristic pyriform apparatus (Figs. 1 and 2). The bulb of the pyriform apparatus is 20 microns in diameter; the embryo proper is provided with six hooks.

AVITELLINA BUBALINAE sp. nov.

GENERAL DESCRIPTION

Ten specimens of this tapeworm, the most complete of which measures at least 4 meters in length, were collected from the small intestines of two carabaos. In the fresh state, the color of the body is white with a bluish tinge; after preservation in formalin, it changes to a perfect white. There is no evidence of external segmentation except in the most posterior region among the gravid proglottids. A longitudinal whitish streak with irreg-

discernible. The segmentation of the body first becomes evident in this region of the strobila, the segments averaging about 0.30 millimeter long by 2.90 millimeters wide by 0.90 millimeter thick.

The gravid region of the strobila.—The segmentation is now more distinct, the proglottids being 0.48 to 0.54 millimeter in length by 0.44 to 0.57 millimeter in width by 0.50 to 0.60 millimeter in thickness. Even the cirrus sacs of the male reproductive system have degenerated, only shadows of them being visible. The vaginae on the other hand are still conspicuous, but instead of running straight to the lateral margins, they are bent or slightly coiled, due no doubt to the shrinking of the body in this region. Their connection with the atrophied seminal receptacles is still visible. The genital pores, which are not prominent, are located in the middle of the margins of the segments. The paruterine organs are now arranged in linear series, one in each segment, as shown in Plate II, Fig. 6. They are globular in shape, 0.135 to 0.170 millimeter in diameter. Each is provided posteriorly with a bladder about 0.100 millimeter in diameter and anteriorly with a pad of connective tissue, which, however, is not very conspicuous. Both the main paruterine organs and their bladders are filled with capsules of minute spherical eggs measuring 13.5 to 17.0 microns in diameter. In some instances eggs are present in the excretory vessels, showing that they may escape to the exterior through the terminal openings of these canals.

DISCUSSION

It is evident from the foregoing description that the tapeworm in question is referable to the genus *Avitellina* Gough, 1911, which Southwell (1929) has redefined as follows: "Strobila thin and narrow; outer segmentation either distinct or indistinct. Longitudinal muscles in a single layer in the cortex, a second smaller layer of sub-cuticular fibers may also be present. A single set of genital organs in each segment. Testes in two or four rows. Cirrus sacs dorsal or ventral and either anterior or posterior to the vulvæ. Genital ducts dorsal to both excretory vessels when two are present. Uterus and paruterine organs single in each segment. Parasitic in ruminants. Type species: *A. centripunctata* (Rivolta, 1874)."

The following species have also been included in the genus: *A. pintneri* Blei, 1921, *A. lahorea* Woodland, 1927, *A. sudanea*

Woodland, 1927, *A. chalmersi* Woodland, 1927, *A. goughi* Woodland, 1927, *A. edifontanea* Woodland, 1928, *A. ricardin* Woodland, 1928, *A. ægyptiaca* Nagaty, 1929, and *A. southwelli* Nagaty, 1929. The present form appears to be most closely related to *A. edifontanea* in the arrangement of its testes in four longitudinal rows and in the shape and linear arrangement of the paruterine organs in the gravid segments. It may be separated from the African species, however, by the following differences: In *A. bubalinæ* the outer rows of testes are 2- to 3-testis deep transversely and the inner rows 3- to 5-testis deep transversely; in *A. edifontanea* they are 1-testis and 7- to 9-testis deep respectively. In *A. bubalinæ* the vulvæ are twice as long as the cirrus sacs, while in *A. edifontanea* the cirrus sacs are longer than the vulvæ.

Specific diagnosis of A. bubalinæ.—Avitellina: Length up to 4 meters or more; maximum width, 2.90 mm., across pregravid segments. Margins of strobila smooth except at posterior gravid region where segmentation is distinct. Four columns of testes, the two outer columns each being 2- to 3-testis deep transversely and the two inner columns each 3- to 5-testis deep transversely. Vulvæ twice as long as cirrus sacs, dorsal to latter on the left side and ventral to latter on the right side. Paruterine organs in pregravid region pear-shaped and arranged alternately on each side of median line; in gravid region they are globular in shape and arranged in straight longitudinal series, each confined within its corresponding segment and containing a posterior evagination or bladder. Eggs *in utero* spherical, 13.5 to 17.0 microns in diameter.

Host.—Carabao (*Bubalus bubalis*).

Location.—Small intestine.

Locality.—Bongabong, Nueva Ecija, P. I.

Type specimens.—Philippine Bureau of Science Parasitological Collection No. 72.

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ILLUSTRATIONS

[Drawings made by Mr. V. V. Marasigan]

PLATE I

MONIEZIA BENEDENI

FIG. 1. Head, lateral view.
2. Egg.
3. Mature segments, dorsal view.
4. Details of reproductive organs, dorsal view.

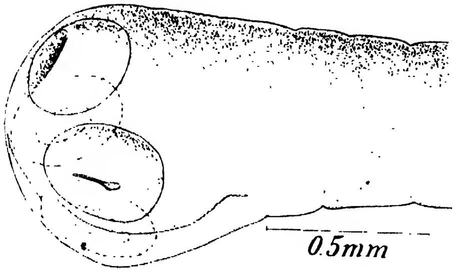
PLATE II

AVITELLINA TUBALINAE, SP. NOV.

FIG. 1. Head, ventral view.
2. Male-mature region, dorsal view.
3. Anterior portion of pregravid region, dorsal view.
4. Cirrus sac and vulva in male-mature segments, dorsal view.
5. Posterior portion of pregravid region, dorsal view.
6. Gravid segments, dorsal view.

ABBREVIATIONS USED

cir = cirrus.
cs = cirrus sac.
ct = connective tissue pad.
e = egg.
ev = excretory vessel.
gp = genital pore.
ipg = interproglottidal glands.
it = internal column of testes.
n = longitudinal nerve.
od = oviduct.
ot = outer column of testes.
ov = ovary.
pb = posterior bladder of paruterine organ.
pu = paruterine organ.
rs = receptaculum seminis.
sg = shell gland.
t = testes.
vag = vagina.
vd = vas deferens.
vev = ventral excretory vessel.
vg = vitelline gland.
vu = vulva.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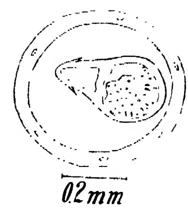
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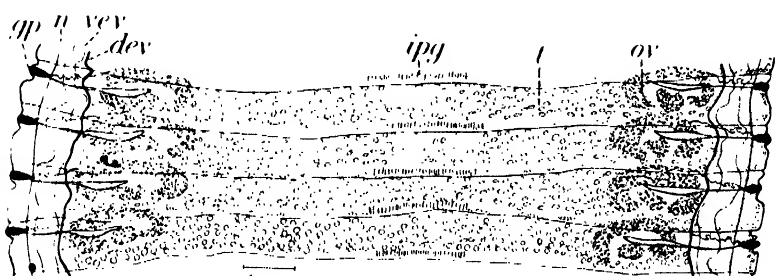
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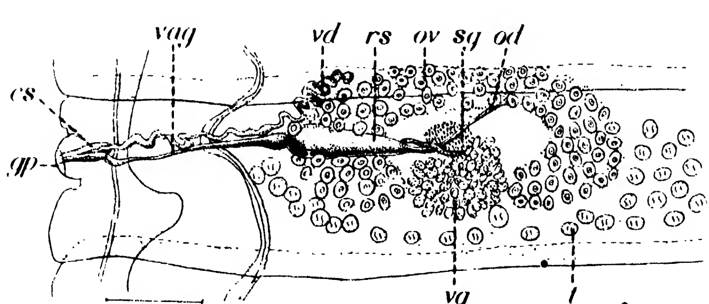
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PLATE I

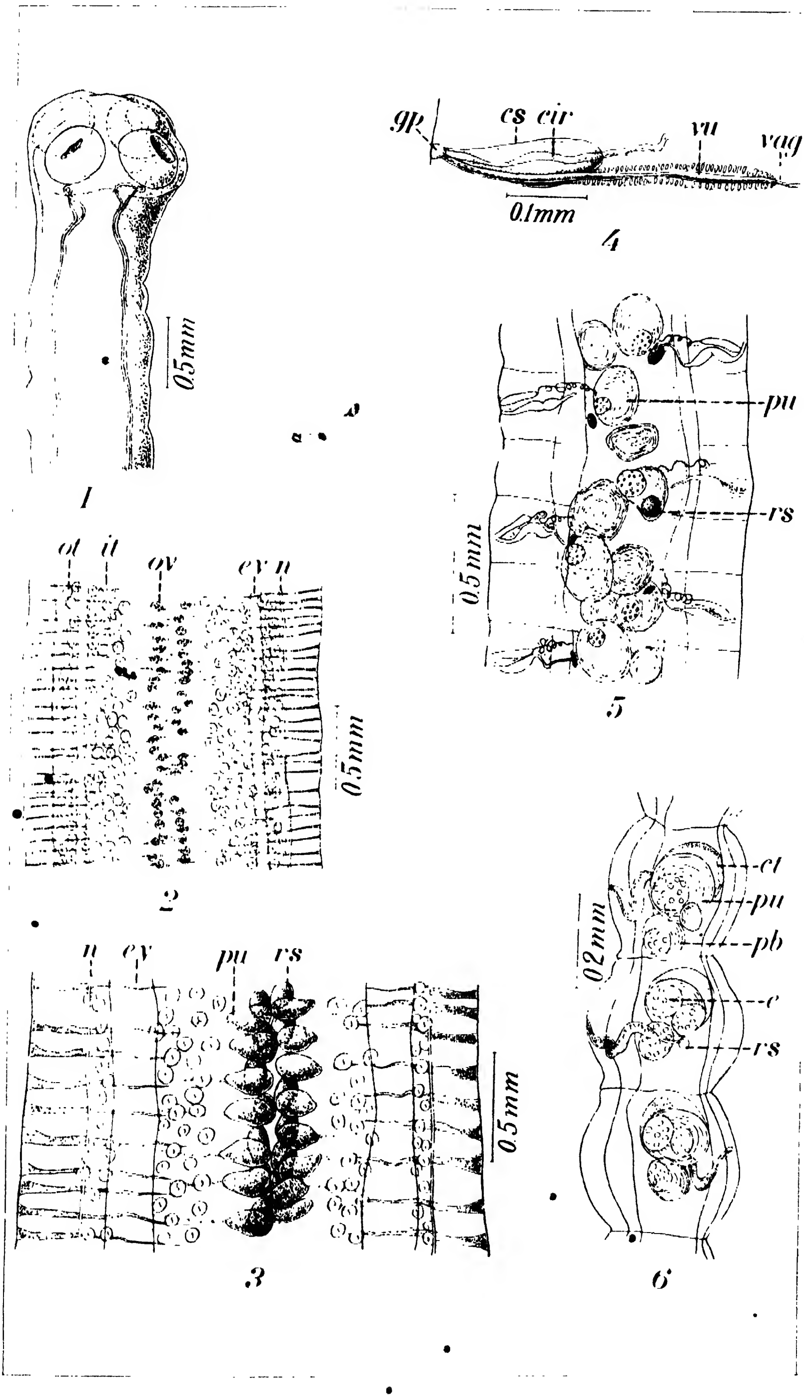
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PLATE II

NOTES ON RURAL VETERINARY PRACTICE IN OCCIDENTAL NEGROS

By MANUEL M. ROBLES, D.V.M.
Of the Veterinary Research Division
Bureau of Animal Industry

ONE PLATE

It was the writer's privilege to work for the Isabela Planters' Association of Isabela, Occidental Negros, as a veterinarian for over a year and a half. An opportunity was thus afforded him to observe closely the incidence of diseases among approximately 2,000 farm animals, mostly cattle and carabaos and a few horses, and to institute practical methods of treatment wherever feasible. In like manner, the management and care of animals followed in the locality were similarly observed. Although the territory and the short period of one year and a half were both too limited to secure any conclusive data, yet the absence of first-hand information on the subject of rural veterinary practice in the Islands alone may justify the writing of this paper, if such an excuse is necessary.

THE TERRITORY

The territory covers an area of about five thousand hectares of rich agricultural land highly adaptable to sugar cane cultivation. It is a flat country which is bounded on its eastern and southern sides by hills which gradually merge with a part of a high mountain range that separates the two provinces of Oriental and Occidental Negros. On its northern and western sides are the contiguous territories of three neighboring towns—La Castellana, Hinigaran, and Binalbagan. The whole area is sugar cane grown except for a few small patches of rice fields and farm sites scattered here and there with a combined area of not more than 200 hectares, so that the absence of grazing areas or lands devoted to feed production, with the exception of a few farms bordering the hillsides, is very noticeable. A large river, the Binalbagan, and its tributaries furnish adequate natural drainage to the territory and at the same time provide all the watering and wallowing facilities for work animals.

Most of the farm sites, with a few exceptions, are located along the banks of the river and its tributaries. There are ap-

proximately one hundred separate farms. Of these only about one-third have an area of more than 50 hectares, while of the remaining two-thirds more than one-half have an area of less than 20 hectares. There is, therefore, a predominance of small farms owning a few work animals over the larger ones where herds of more than 20 are maintained.

INCIDENCE OF DISEASES

The most common diseases met in the order of their abundance were: castration wounds (88); wounds (48); foot-and-mouth disease (40); emaciation (40); abscess (14); pododermatitis (14); fistula (9); and traumatic keratitis (8).

There were 44 varieties of diseases diagnosed; of these, 28 were surgical cases while the remainder were medical. Foot-and-mouth disease, surra, epizoötic lymphangitis, and malignant catarrhal fever (?) were the infectious and communicable animal diseases registered. Parasitic diseases, viz., oxyuriasis in horses, gastric and hepatic distomatosis in cattle and carabaos were also found.

A few unusual and interesting cases met with were the following: (1) forage poisoning in a horse; (2) rupture of the bladder in a carabao; (3) scleral papilloma in a carabao; (4) malignant catarrhal fever in carabaos; (5) heatstroke in carabaos; and (6) unidentified diseases in carabaos (two cases).

A total of 326 cases were handled and disposed of as follows:

Abscess	12
Alopecia	1
Arthritis	1
Castration wound	88
Colic	2
Conjunctivitis	2
Contusion	3
Cystitis	1
Enteritis	1
Emaciation	23
Fistula	5
Foot-and-mouth disease	39
Gangrene	2
Gastritis	2
Heatstroke	1
Hematoma	2
Horn fracture	2
Keratitis, traumatic	4
Lymphangitis, epizoötic	2
Luxation, patellar	1
Mammitis	1

Oxyuriasis	2
Papilloma, cutaneous	3
Papilloma, scleral	1
Pododermatitis	12
Shoe boil	1
Sprain	1
Tympanitis	2
Ulcer	2
Wound	47
Total cured	265
Abscess	1
Corn	1
Emaciation	6
Fistula	4
Keratitis, traumatic	4
Pododermatitis	2
Lampas	1
Total improved	19
Fracture	1
Luxation, acetabular	2
Polyps, nasal	1
Total condemned	4
Abscess	1
Enteritis	2
Foot-and-mouth disease	1
Emaciation	11
Gangrene	1
Gastro-enteritis	2
Heatstroke	1
Laryngitis	1
Lymphadenitis	1
Malignant catarrhal fever	2
Otorrhea	1
Ophthalmia, periodic	1
Poisoning, forage	1
Rupture, bladder	1
Surra	5
Tetanus	1
Tympanitis	1
Unidentified	2
Ulcer	1
Wound	1
Total died	38

DISCUSSION OF THE COMMON DISEASES

ABSCESS

Fourteen cases were met with, six of which were of long standing. The yoke region of the neck was the usual seat of the disease, although the buttocks, hips and shoulders were also affected. The primary causes were mostly traumas.

Treatment consisted in opening the cavity (using the usual aseptic precautions), establishing drainage at the most suitable points, and further removal of the capsule by chemical cautery. For this purpose powdered copper sulphate wrapped in gauze and packed tightly into the cavity gave satisfactory results. Sloughing of the capsule usually followed in 3 to 4 days. In a few instances the above cauterization process was repeated in order to effect complete removal of the capsule.

Further treatment consisted in handling the cavity as an open wound. In some cases, occasional enlargement of the drainage openings was done to facilitate good drainage until healing was complete. In three mild cases complete resorption was effected by the application of a blister (cantharides blister 1 : 6).

CASTRATION WOUNDS

Eighty-eight cases were handled, the majority of which were cattle and carabaos. The open method of castration, using the circular incision around the tip of the scrotum and adopting the emasculator for severing the cords, was used. No undesirable sequels were observed except in two cases, where a post operative hemorrhage followed. This was controlled by ligation of the cord. A long dressing forceps, like the Boseman's was found very useful in these instances, in locating and drawing out the stump of the cord for proper ligation.

In all cases a fly-repellent 5 per cent tar ointment containing naphthalene, was the after-dressing used. This was applied in and around the wound once daily until healing was complete, usually taking place in from 7 to 14 days. There were a few cases that became infected with fly maggots. For killing these maggots pure chloroform applied as a pack into the wound cavity was found effective.

EMACIATION

This term is applied arbitrarily to a condition of gradual inanition brought about mainly by excessive work and insufficient feed, together with other debilitating factors as internal

parasites and exposure to bad weather. There was a total of forty cases observed among carabaos, of which eleven died.

Almost all the cases began by a noticeable loss of appetite and marked debility. In severe cases the animals grew thin and inappetence remained until death, while in mild cases there was a gradual improvement of the appetite and health following a prolonged rest and judicious feeding and care. The others that failed to recover remained emaciated and unable to work until disposed of by the owner.

Autopsy of several cases revealed the presence of internal parasites, such as the stomach flukes (*Fischoederius elongatus*) in the rumen and liver flukes (*Fasciola hepatica*) in enormous quantities. As much as one-half liter to a liter of the former was collected; while liver flukes were found to fill up the large bile ducts in two instances. Besides the parasitic infestation, secondary lesions of the heart were also observed in three cases. In each case the heart was pale (cooked appearance), the heart muscle was soft and flabby, and the pericardial fat was absent (instead there was a gelatinous tissue on the coronary grooves). In two other cases, white thrombosis (octopus-like) of the heart and large blood vessels was also found.

FISTULA

There were nine cases registered. All of them began as abscesses of the neck which had been opened at the wrong place. Consequently drainage was inadequate, which eventually led to the formation of pus pockets and suppurative sinuous tracts. The condition, though apparently harmless, invariably made the animals affected unfit for work as the parts remained sensitive to pressure.

Attempts were made to cauterize the fistulous tracts with liquid caustics followed by the injections of oleaginous antiseptics but proved useless, except in five mild cases where healing took place after several months.

FOOT-AND-MOUTH DISEASE

The disease appeared in two farms, affecting in all forty head of cattle and carabaos and causing the death of one. Most of the cases recovered in one or two weeks, although they were not fit for work until after about one week of further convalescence. Where foot lesions developed and lameness followed, the animals were unable to work for over a month.

Treatment was confined to local applications of a saturated solution of borax to the ulcers of the mouth and tongue and creolin baths (2 per cent) for the feet. Where ulcers and hoof cracks developed, zinc oxide ointment containing 2 per cent phenol was satisfactorily used. Judicious feeding was also found very essential for quick recoveries.

TRAUMATIC KERATITIS

Of the eight cases observed, four were due to the adhesion of the seeds of *amores secos* (*Andropogon aciculatus* Retz), a common weed that grows abundantly everywhere. As many as three seeds were found embedded in the cornea. The condition was always accompanied by severe lacrimation and photophobia. Removal of the offending objects and subsequent treatment of the corneal wounds with antiseptics were followed by recovery in all cases.

The remaining four cases that failed to recover were caused by severe wounds of the cornea, that were followed by severe productive inflammatory processes.

The usual eye lotions and antiseptics such as zinc sulphate solution (1 per cent), silver nitrate solution (1 per cent), and yellow mercuric oxide ointment (5 per cent) were satisfactorily used. The latter was found most suitable especially for fresh wounds of the cornea.

PODODERMATITIS

This was an aseptic inflammatory condition of the pododerm or sensitive structures of the hoof caused by contusions. The sole was the usual part affected, although the sensitive laminæ were also involved in some instances. Five of the fourteen cases observed were caused by an overgrowth of the horn of the sole, occurring mostly on the bars and heels, while the remainder were due to heavy draft on rough roads, or hard blows inflicted on the foot.

Treatment consisted mainly in the application of warm poultices to the feet for several days and complete rest for one or two weeks. Horn overgrowths were also removed when present.

SURRA

The following five cases were observed only among bullocks. In all of them trypanosomes were found.

Case 1.—The animal was staggering and trying to walk backward with the head carried low. Finally it fell and died after 15 minutes. The post-mortem lesions consisted of a few petechiæ on the myocardium and on the subserous coat of the intestines, slight yellowish discoloration of all organs, and blood coagulable with difficulty.

Case 2.—Two weeks before, this animal had suffered from a peculiar sloughing of the skin, leaving lesions like a second-grade burn which varied in sizes from a hand palm to a pie plate. They were located on the croup, sides, and neck. The horns were also sloughed off. The lesions were gradually healing when one morning the animal was found down and unable to stand. The eyes had an anxious look. The pulse was imperceptible and breathing was dyspneic. Rectal temperature was 38.7 degrees Centigrade. The animal died three days later.

Case 3.—The animal was worked the previous day. The following morning the animal was down on the side and unable to get up. The eyes were highly congested. Rectal temperature was 40 degrees Centigrade. The animal died the next day.

Cases 4 and 5.—Animals manifested general debility with marked weakness of the hind quarters for the last two or three weeks. They were finally unable to work. One of these developed an edematous swelling of the jaw and dewlap accompanied by a severe diarrhea, while the other showed only marked emaciation. Both animals finally died.

WOUNDS

Forty-eight cases were registered. This group of diseases was the most troublesome to handle under farm conditions due to the abundance of flies.

A small wound invariably grew large by the burrowing and irritating effects of the fly maggots so that an effective fly-repellent was extensively used, aside from the usual surgical procedures in wound treatment as establishing good drainage, followed by a thorough mechanical and chemical disinfection together with the subsequent application of antiseptic powders and ointments. For this purpose tar ointment (5 per cent) containing naphthalene was found to be both cheap and efficient. For antiseptic dusting powders, one containing boric acid, tannic acid, and wood charcoal (2: 1: 2) gave very satisfactory results for moist wounds; but for dry healing wounds zinc oxide

ointment (U. S. P.), to which phenol 1 per cent has been added, was used.

UNUSUAL AND INTERESTING CASES

FORAGE POISONING (BOTULISM)

Subject: Australian horse, gelding, about 12 years old. The animal was observed lying on the side, panting heavily and sweating profusely. Then he got up but regained his feet with difficulty, there being a trembling of the legs and body. He went up and down three or four times as if suffering from abdominal pain. While on his feet he attempted to eat but was unable to swallow, or he dipped his mouth in a bucket of water but was unable to drink. There was an apparent paralysis of the pharynx. The pulse was fast and full; respiration was markedly accelerated and dyspneic; but temperature was normal. Finally, several hours later the animal became comatose and died the following night, approximately 14 hours after the first symptoms were shown. An autopsy revealed no lesions, except a mild icteric discoloration of all tissues of the body.

RUPTURE OF THE BLADDER

Subject: Male carabao, about 10 years old. The animal was observed to lose appetite for the last few days and in addition there was observed a marked abdominal enlargement. The animal was found resting in the normal recumbent position but was made to stand with difficulty. The abdomen was well distended which made locomotion difficult.

The case was diagnosed as tympanitis. The animal died the next day. An autopsy showed the presence of about 16 liters of a straw-colored fluid in the abdominal cavity. The bladder was found to be thickened (chronic cystitis with ulcerations) and showing a hemorrhagic rupture at its ventral aspect at about 2 inches from its apex. Besides this, there were two other hemorrhagic thin spots on its wall, showing partial rupture.

SCLERAL PAPILLOMA

Subject: Male carabao, about four years old. Lacrimation and difficulty in opening one eye was observed by the owner. Examination revealed the presence of a cauliflower-like pigmented tumor (size of a Spanish pea) on the eyeball at the corneo-scleral junction. The tumor caused a depression and an intense opacity of the cornea. It was successfully removed with a pair of scissors and recurrence did not follow.

MALIGNANT CATARRHAL FEVER (?)

Two cases in carabaos were observed. Although rinderpest which is prevalent in the locality, croup of cattle and infectious keratitis may cast a shadow of doubt on the diagnosis, yet the non-contagiousness of the cases (only two animals affected in a herd of 40 cattle and carabaos), the marked eye and nervous symptoms, post-mortem lesions (of one case) and their acute fatal course, were very similar to those described by some observers in positive cases of malignant catarrhal fever. One of the two cases that was autopsied will be described below.

Subject: Carabao, male, 12 years old. The animal was found sick 20 days after the first case was reported. Temperature was 39.7 degrees centigrade; pulse was imperceptible; and respiration was 22 per minute.

Both eyes showed a reddening of the conjunctiva which later became more hyperemic and edematous, and finally becoming everted. A muco-purulent discharge began to appear on the third day. The cornea became gradually turbid. A nasal secretion, which was at first mucoid, became yellowish muco-purulent on the third day. The buccal mucosa was swollen and bluish-red, especially at the gums. Erosion ulcers covered with yellowish diphtheritic deposits were also found on the gums and dental pad. Diarrhea appeared on the fourth day (not bloody as in the first case). The general attitude of the animal was a marked indifference to his surroundings, head carried low, and marked debility as showed by a wobbling gait. On the third day pneumonic symptoms began to appear. Respiration was fast and labored. On auscultation moist rales were audible.

The animal died on the fourth day.

The post-mortem lesions were: Mucosa of the nasal meati and frontal sinuses was congested and covered with a yellowish croupous exudate. The buccal mucosa showed erosion ulcers on the gums and dental pad. The pharynx and trachea were filled with a croupous exudate covering a mucosa of a dirty reddish hue. The bronchi and bronchioles were also filled with a muco-purulent exudate and there was congestion and red hepatization of the apical and cardiac lobes of both lungs. Petechial hemorrhages at the coronary grooves and a rough thickening of the pericardium were also found. The digestive tract showed a bluish red discoloration of the mucosa. The gall bladder was extremely distended, filled with about a liter of thin bile. The spleen was normal. The bladder showed marked ulcerations

on the mucosa (size of mustard seeds and tapioca). There was a yellowish discoloration of the subcutis.

TWO CASES OF HEATSTROKE IN CARABAOS

One of the cases was very mild for the animal recovered after a few hours of rest in the shade.

The other was of the severe acute type for the animal died within six hours after the first symptoms were shown. The following were the symptoms manifested: The animal was heavily at work one sultry day when all of a sudden he fell and was unable to rise. Efforts to make him stand proved useless. The rectal temperature was 41 degrees centigrade; the recpiration was fast and dyspneic; and the pulse was imperceptible. The eyes were severely congested. Foaming of the mouth was also noted.

The animal died four hours later. On autopsy, the heart muscle was found pale and flabby; the lungs slightly congested; and mesenteric blood vessels extremely distended with blood.

TWO UNKNOWN SIMILAR DISEASES (CARABAOS)

The two cases were found in two widely separated places, but both had identical histories and symptoms.

While on pasture the animals fell and were unable to rise in spite of all efforts to make them do so. The condition of both animals had been excellent. The temperature was normal; the respiration was dyspneic, apparently due to the recumbent position; and the pulse was imperceptible. The appetite was not impaired and consciousness was normal even until a few days preceding death. In both cases death was due to the extensive decubital sores that subsequently developed. Blood examination was negative to blood parasites and other microörganisms.

CARE AND MANAGEMENT OF ANIMALS

Inasmuch as the care given to work animals varies with the system of farm management, mention will be made briefly of the two fundamental systems that are being followed in Negros, viz.; the *aparcería* and the administration. The *aparcería* system consists essentially in the subdivision of the farm lands into lots which are apportioned among individuals or *aparceros* for cultivation. The farm is thus composed of these *aparcería* units, each being worked independently but supervised and coördinated by the farm owner or his representative. In the administration system, however, the farm is cultivated as a single

unit by hired laborers who are closely supervised by an *encargado* (superintendent), rarely by the owner himself.

From the standpoint of care and management of animals, the *aparcería* system offers the best advantages. As the work animals are owned by the *aparceros* or the farm owners themselves, usually in small groups of two or three, the best care and attention possible are readily given them. Comfortable quarters and feed in abundance are always provided for them. Overworking the animals is not resorted to. As a whole the animals are maintained in the best of health and working condition.

In sharp contrast to the above, the administration system presents no commendable features. A collective method of managing the animals without regard for their health and comfort is usually followed. Animals are worked on schedule time, regardless as to whether some of them are able to hold out or not, and in this way many are overworked to exhaustion which eventually leads to gradual emaciation and finally death. At night the animals are kept together in a muddy unroofed corral where they are exposed to insect bites and inclement weather. Furthermore, it is not uncommon to see animals feeding on overgrazed pastures or on some nearby vacant lot with practically nothing to feed upon. Weeds that are available from the cane fields at certain months of the year or the cane tops during the milling season are also given them, but as a rule no attempts are made to provide adequate sources of feeds throughout the year; much less to institute correct methods of feeding. The tendency to underfeed animals is thus very great, if not very common. This is especially true during the busy season of the year when animals are worked heavily, so that the average useful life of the animals is thus considerably shortened to from 3 to 4 years.

POSSIBILITIES FOR VETERINARY PRACTICE

The writer is of the opinion that veterinary practice in the locality for the present time is of doubtful possibilities. There are a few fundamental factors that make it so. First, there is the prevalent attitude of indifference among most livestock owners towards the veterinary service, traceable directly to their ignorance of the latter's usefulness and capabilities for service in many instances. Consequently in such an atmosphere of indifference or lack of spontaneous coöperation results are bound to be unsatisfactory for both livestock owner and veterinarian. Many cases will certainly go from bad to worse, de-

layed in their recovery and eventually be declared incurable or terminate in death due to mere neglect and unwillingness of the owners to provide the right feeds and care incident to the treatment of such cases. Second, the scattering of many cases over an extensive area precludes the exercise of close personal attention and supervision so that the degree of success attainable under such circumstances will depend largely on the intelligent coöperation of the livestock owners and adaptable transportation facilities for the practitioner. At the present time the first requisite is hardly obtainable, while the second is usually beyond the means of the average veterinarian. Third, although a large number and variety of cases have been registered as shown by the preceding data, yet it is very doubtful if many of them would have ever come to the attention of a veterinary practitioner if he were other than an employee. From a remunerative standpoint, therefore, the possibilities for veterinary practice are problematical, if not negligible.

ILLUSTRATIONS

PLATE I

(*a*) Malignant catarrhal fever (?) in a carabao. Note the muco-purulent discharge from the eyes and nostrils. Opacity of the cornea and eversion of the conjunctiva were also present.

(*b*) Complete acetabular luxation in a cow caused by slipping. Note abnormal abduction of the right hind limb above the stifle joint.

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PLATE I

THE RELATION OF DOMESTIC ANIMALS TO HUMAN HEALTH [1]

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It would indeed be difficult to estimate the value of domestic livestock to the human race, both from the economic and the human health point of view. A moment's reflection reminds us of our utter dependency upon our domestic animals and the raw materials and supplies derived from them. These include not only meat and milk, but also ham, bacon, lard, butter, cheese and the raw materials for leather and a long list of other by-products. We are particularly dependent upon cattle and carabao in the Philippines, where the agriculturist would be unable to till the soil without their help—and it is an undisputed fact that upon agriculture depends the prosperity of these Islands and also human health, which is thus dependent in large measure upon animal health.

It is in the consumption of meat and milk and in diseases transmissible from animals to human beings that our domestic animals play the largest part in the problem of promoting human health. Let us first consider the question of meat consumption, since we know the value of meat in the diet in its relation to physical strength and consequent relative resistance to disease.

In a speech which he made on the floor of the House of Representatives during this session of the Legislature, Representative Montilla called attention to the fact that the Filipino laborer, with all his industry, with all his willingness to deserve his pay, with all his good intentions, can attain no more than half of the efficiency of foreign labor. This condition he attributes, in a large measure, to infestation with intestinal parasites. But may not the poor physical condition to which he refers be due, at least in some measure, to low consumption of

[1] Excerpts from a paper read before the Health Education Club, University of the Philippines, on November 6, 1930.

meat? In comparison with foreign countries, we find that the Filipino consumes an exceedingly small quantity of meat.

While there are sufficient cattle to supply the demand, the low consumption per capita indicates the need for lower prices in order to encourage increased consumption, which can be brought about by improved breeding and marketing methods. Acquainting the public with the solution to the problem of making 2 kilos of beef grow where but one grew before, and that of supplying an adequate quantity of pure milk at a fairly low price, are among the principal functions of the Bureau of Animal Industry.

The need for education along the lines of breeding, feeding, care and management of animals for the production of both beef and milk is particularly great in a country like this where up-to-date scientific methods are not generally known.

Another important function of the Bureau of Animal Industry is animal disease control. This phase of our activities is also of the utmost importance from a human health standpoint, for all diseases to which animals are heir have a bearing on human health, either directly or indirectly. Directly, through providing a source of infection to human beings by diseases transmissible from animals to man; and indirectly, by the economic loss involved in the death or lowered usefulness of animals, for only the prosperous can buy the food which maintains good health. Formerly, the disease rinderpest, not communicable to human beings, caused the greatest financial loss to farmers in the Philippine Islands. There have been times in the past when the number of work animals destroyed by this dreaded disease has been so great that it practically stopped farming operations in some sections and reduced farmers to poverty, as in 1900. During the past few years, however, rinderpest has ceased to be such a serious problem. However, all diseases of animals, even those not communicable to human beings, have a more or less deleterious effect on human health; for the meat taken from animals killed in a febrile condition may cause digestive disturbances.

The control of diseases transmissible to human beings is of the utmost importance. In its larger aspects, this is brought about in a great measure by Government control of meat and milk inspection.

The meat supply of Manila is safeguarded by the Insular Government meat inspectors employed by the Bureau of Animal

Industry. All livestock slaughtered at the local slaughterhouses must undergo careful ante-mortem and post-mortem inspection, which is done according to the rules and regulations prescribed by the United States Bureau of Animal Industry. In addition, stores and public markets selling meat are regularly inspected by the Bureau of Health, not only to pass upon the condition of the meat offered to the public, but also upon the sanitary condition of the place where the meat is kept for sale. During the year 1929, of the 3,670,077 kilos of meat passed for food obtained from 26,119 animals, 87 entire carcasses were condemned as unfit for human consumption, and of those remaining, 42,438 parts were condemned for various causes, of which congestion 7,065 parts, parasitic infestation 5,505 parts, inflammation 4,300 parts, tuberculosis 3,070 parts, emphysema 2,016 parts, were the most common.

While meat inspection in Manila is as good as can be expected under the circumstances, the conditions under which it is done are far from satisfactory, as the Azcarraga and Pandacan Mataderos are old, out-of-date buildings which lack up-to-date equipment for properly handling passed and condemned meat. The Philippine Coöperative Livestock Association, which in May, 1930, entered into an agreement with the Government of the Philippine Islands to supply a minimum monthly quantity of from 250,000 to 310,000 kilos of fresh dressed beef, has plans and specifications for an up-to-date slaughterhouse awaiting approval. When in operation, this slaughterhouse should provide facilities for meat inspection unsurpassed anywhere. It is, however, particularly in the provinces that much needs to be done to bring meat inspection up to anywhere near a satisfactory state; and this is not likely to occur until public opinion demands a change for the better. It is here especially that teachers in health education can render an invaluable service in promoting health by pointing out the dependence of human health on animal health and moulding public opinion to demand better conditions.

Dairy inspection at the present time is by law under the direction of the Bureau of Health, only the testing of dairy cattle for tuberculosis being delegated to the Bureau of Animal Industry. While some testing of dairy herds for tuberculosis infection was done in the past few years, vigorous measures to suppress tuberculosis in dairy cattle were only started last year, and then only in the seven dairies located in and near Manila and three dairies in Baguio. Five hundred seventy-five dairy

cattle were tested in 1929 and 890 in 1930. As a result of this testing, the incidence of tuberculosis was lowered from 17 to 11 per cent, but it would have been reduced much more had all the positive cases been promptly removed and proper disinfecting measures put into effect immediately.

The tuberculin test of dairy herds is a dependable method of detecting tuberculous cattle, its efficiency being acknowledged as equal to that of any other biological test. As a result, certified milk herds in the United States are today, and have been for years, so free of tuberculosis that any chance of human infection with the cattle type of tuberculosis germ through certified milk may be regarded as nil. Much the same may be said for the human diseases typhoid fever and diphtheria. Under the supervision of the medical officers of active medical milk commissions and with the present facilities for detecting carriers, the transmission of these diseases through certified milk can be and is prevented. To quote from a recent editorial in the New England Journal of Medicine:

> Certified milk rarely comes, now, from tuberculous cattle; it is almost unheard of to have typhoid fever, scarlet fever or diphtheria occur as a result of its use.

Adequate supervision of a community's milk supply involves detailed, periodical inspections of dairy farms, their equipment, methods, water supply, health of cattle, health of employees, etc.

Another important phase of milk-supply control is the routine bacteriological examination of milk. Such examinations are made principally for the purpose of determining the number of bacteria present in a given specimen. It is obvious, of course, that the mere determination of the number of bacteria present in milk is no definite index as to whether or not it is safe for human consumption. A small number of typhoid, scarlet fever or diphtheria organisms would render milk of a low total bacterial count very dangerous, while, on the other hand, milk containing hordes of non-pathogenic bacteria might be consumed with no ill effects whatever. The value of the routine bacterial count lies in the fact that the number of bacteria present is an index to the efficacy of the methods of production and handling. A high bacterial count over a continued period ordinarily is indicative of unsatisfactory conditions at the dairy; of careless and inefficient methods. Milk produced under such conditions is, obviously, more apt to become contaminated with organisms detrimental to the health of man than milk produced under ideal conditions.

While for a long time bacterial counts have constituted one of the best standards for judging, at a distance, the sanitary conditions surrounding the production of milk, passing up to scale in grades of milk from the poorest to the best, bacterial counts within a certain grade have diminishing significance. This is particularly true within those grades of milk which have a low germ content. This can be done by determining the types or kinds of bacteria present, knowing that certain types are normal inhabitants of milk, whereas other types are abnormal and should not be present in appreciable number. Rather simple tests are now made which permit the classification of predominant types as either lactic acid, peptonizing, putrefying, gas-producing or combinations of these. Such grading is based on fermentation and curd tests, the results indicating in a general way good quality, fair quality, bad or very bad, according to the predominance of types in the order above given. Knowing the diseases of man that occasionally, although rarely, are transmissible through milk, it should be possible to operate safety measures that will eliminate such potential sources of infection at the source. This means an agency for the application of preventive human and animal medicine in their modern form. This agency takes definite form in the control laboratory, the function of which begins where medical and veterinary supervision leave off, and by supplementing the work of the doctor and veterinarian, carries them to a forceful and rational conclusion.

The best milk possible to produce is certified milk, which is produced under the supervision of a Medical Milk Commission, the certificate of such commission indicating that the producer is complying with various specified requirements, sufficiently stringent to insure a safe, wholesome, raw milk. The exact requirements differ somewhat with different commissions. In the main they cover, in a strict manner, the health and care of the animals, health of employees, equipment, sanitation, methods, storage, delivery, chemical constituents and bacterial content of the milk. In the bacteriological examination of certified milk, the official plate count must not exceed 10,000. Certified milk is not produced in the Philippine Islands at the present time. It is safe to say that dairies here will not produce milk of the high quality which the people should have until public opinion crystallizes in a demand for a better product.

Of the diseases transmissible from animals to man prevalent in these Islands, perhaps the most extensive relationship exists in the field of animal parasites, the most important of which are

the worms. Echinococcosis is a disease of man, sheep, cattle, and swine characterized by the presence of hydatid cysts, and caused by the larvæ of the small tapeworm, *Tænea echinococcus*, that live in the intestine of the dog. *Tænea saginata*, a tapeworm commonly found in the intestines of man, is acquired by eating raw beef where the larvæ are found, and *Tænea solium*, also found in the intestines of man, is acquired by eating inadequately cooked pork. Trichinosis is another parasitic disease of man caused by the presence of *Trichina spiralis*, when undercooked trichinous pork is eaten. The infestation with *Ascaris lumbricoides* is traceable to swine. Since the incidence of these diseases is largest where sanitary conditions are worst, the coöperation of health educators should aid materially in bringing about an improvement.

Of the other diseases affecting animals and man, it is well known that tuberculosis is the most important here. While the number of cases have not been reported, the Annual Report of the Director of Health for 1928 gives 31,082 deaths from this disease alone. Next in importance come anthrax, 159 deaths, and glanders, 2 deaths; typhoid and paratyphoid, which may be carried by milk, 1,575 deaths.

Animal health education is in its infancy here. Up to the present time it has been largely confined to exhibitions demonstrating animal husbandry and animal disease control methods in carnivals and *fiestas*, printed pamphlets, and occasional news items. While these methods are valuable, the greatest benefit would be derived by having appropriate lectures on animal health and animal disease control incorporated in appropriate courses in all private and public schools. However, until such time as these lectures become a regular part of the curriculum, teachers in health education can render an invaluable service by arranging their courses so as to provide at least one or two lectures on the relation of animals to human health; for it cannot be too strongly insisted upon that human health depends in no small degree upon animal health.

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